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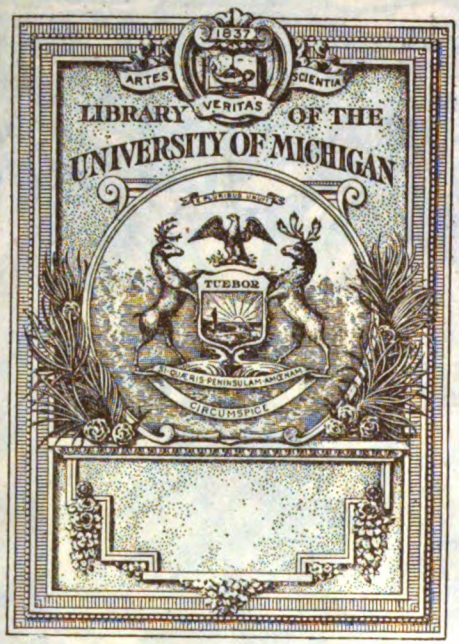
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The Journal

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LECTURE.

Friday, January 18th, 1867.

REAR-ADMIRAL SIR JOHN C. DALRYMPLE HAY, Bart., M.P., F.R.S., &c., &c.; in the Chair.

ON THE MODES OF DETERMINING THE ACCURACY OF ARTILLERY.

By Professor WM. POLE, F.R.S., Memb. Inst. C.E., late Member of the Iron Armour Plate and the Armstrong and Whitworth Gun Committees.

HAVING been for some years connected officially with Government investigations on Artillery and on Iron Defences, I have been frequently asked to give papers to this excellent Institution; but I have long hesitated, partly because it was inconvenient to enter upon matters open to much controversy while I was immediately engaged in official enquiries thereon, and partly because, being a civilian, I felt diffident in treating of subjects more properly belonging to the professions for whom this Institution was mainly intended.

It happens, however, that in the course of the enquiries I have alluded to, a subject has engaged my attention, which is not only independent of all controversies as to the merits of particular offensive or defensive systems, but is of a nature that a civilian may treat of without presumption.

In the investigations connected with the Armstrong and Whitworth Rifled Artillery, it became essential to contrive some good means of testing and defining the *accuracy* of guns, and as I could not find that the subject had ever been thoroughly treated of, I was led to reason it out for myself. The result of my investigations was communicated, now some years ago, to the Royal Artillery Institution at Woolwich, and was published by them in 1865. What I am now about to do is

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to explain, orally, some of the reasonings and conclusions stated in that paper.*

Firing for Accuracy, whether with artillery or small arms, may involve two entirely separate and distinct things.

1. The determination of the personal skill of the individual using the weapon.

2. The determination of the qualities, as regards accuracy, of the weapon itself.

The first of these is the more popular subject, and it has, as we all know, been much developed of late by the volunteer rifle matches. It involves some interesting questions for scientific discussion, but it is no part of my business to speak of it here.

Our attention must now be confined to the other enquiry, and to the artillery branch of it, viz.: what is the best mode of determining the accuracy of a gun? Or having several different guns to be tried, what is the best mode of comparing their qualities as regards accuracy?

The simplest mode we can conceive of carrying out such a trial is to suppose a target erected, at the required distance, large enough to receive all the diverging shots; to place the gun, at every round, with its axis exactly in the same position, and to note the arrangement of the various shots on the target. In proportion then as these shots are closer, or more condensed and compact, the gun will be more accurate. In proportion as they are wider or more scattered, the accuracy will be less. But there are two serious objections to this simple process. In the first place, it is almost impossible to eliminate the element of *personal skill* in laying the gun. And, secondly, it is impracticable, at long ranges, to get targets *large enough* to comply with the necessary conditions; particularly with guns like the old smooth bores, whose shooting is inaccurate and wide.

For these reasons, the accuracy of guns, instead of being made the subject of special testing, has generally been *deduced* from another sort of trial, originally designed for a different purpose, namely the determination of the *range* which a gun will give, with a given loading, and a given elevation. To carry out this, a site is chosen where there is a long expanse of sand (level or nearly so) on which a straight line is drawn with stakes at different distances. The gun is then placed with its axis directed carefully along this line, and with the given elevation accurately determined by a gunner's quadrant, with spirit-level attached, placed in the bore. The gun is then fired, and accurate note taken of the spot where the shot fell in the sand. When several rounds have been fired, all under the same circumstances, the positions of the various marks are compared. The longitudinal differences shew what is called the *variation in range;* the positions on either side of the line shew what is called the *lateral deviation*, right or left, as the case may be.

* The extracts from the paper mentioned are published with the permission of the Royal Artillery Institution.—W. P.

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It is easy to see therefore that as the shot are closer or wider apart, or in other words, as the *variations*, *in range*, or *laterally*, are less or greater, the gun may be pronounced more or less accurate. Thus the objects of the target method first mentioned, are attained by a mode more practical, and less open to objection. It amounts simply to placing the target *horizontally* instead of *vertically*, and to substituting for a personal aim, an instrumental determination of the position of the gun.

The rough estimate of the comparative accuracy of guns, deduced in this way, has answered very well for the old sorts of guns, where much delicacy of estimation was not necessary; but on the introduction of Rifled Artillery, it was soon seen that the accuracy was so important an element in the improvement, as to deserve more careful consideration.

The first scientific step in this direction was taken by Captain Andrew Noble, who, in 1859, published a paper in the Woolwich Artillery Proceedings, "On the application of the Theory of *Probabilities* to "Artillery Practice," the principal object of which was to point out a mode of defining and comparing the accuracy of ordnance of various kinds.

Retaining the principle of noting the position of the shots as they fall on a horizontal plane, Captain Noble shows it is possible to define a certain rectangle, supposed to be drawn on the ground where the shot fall; and which rectangle will denote the space within which it is *an equal chance that any shot will strike;* or (which is the same thing) within which *half the shot* will certainly fall in a very large number of rounds.

This is called the "probable rectangle," and the use of it is, that its *area* may be considered to be a measure, inversely, of the accuracy of the gun.

Thus a gun which, fired at the same range and elevation makes a "probable rectangle" half the area of that given by another gun, may be said to be twice as accurate; and so on.

The process by which Captain Noble calculated the probable rectangle, from the positions of the shots on the plane, was singularly elegant; and the new method of estimating accuracy received a wide sanction and adoption by the highest scientific authorities in artillery practice.

Since, however, the date of Captain Noble's paper, rifled artillery has taken a great and rapid development; its manufacture has been much improved, and its accuracy has been consequently much increased; and it has been found that the problems involved in the testing and determination of the comparative accuracy of different kinds of guns, are more intricate than was at first anticipated. Hence, Captain Noble's method, though perfectly correct and applicable as far as it goes, does not fully provide for all that the enlarged form of the problem requires.

I have discussed the matter frequently with scientific artillerists, and have found such a difference of opinion on many important points, that I have been led to review the subject from the beginning; and while adhering generally to the mode of reasoning adopted by Captain

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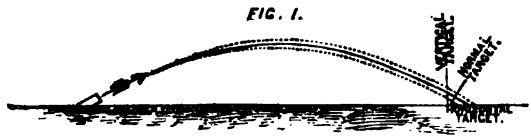
Noble, I have endeavoured to introduce some further elements which I think the subject demands.

I will proceed therefore to state in as clear and simple a manner as I can, the results at which I have arrived.

Premising that the accuracy of a gun must always be tested by a large number of shots fired, with the axis in a fixed direction, the first question is, as to the *position of the target* on which these shots shall be received and recorded.

There are three ways in which the target may be placed, and which will be at once explained by the following figure.

FIG. 1.



In the first place, the target may be a *horizontal* one, *i.e.*, the shot may be allowed to fall on some level surface, as is the usual way when practice is carried out on the sands.

Or secondly, the target may be placed *vertically*, which is the usual way, I believe, in small arm practice.

Or thirdly, it may be placed at right angles to the line of trajectory, so that the paths of the various shots (which may for this purpose be assumed parallel at that point) will be *normals* to the plane of the target. It is clear that this (although I am not aware that it has been before proposed) is the most correct position, as being the only one in which the errors of the shot in the direction of range are represented on the target without distortion. I call it the *normal target*, and propose throughout this paper, unless otherwise stated, always to consider the target as placed in this position.

It is right, however, to state that, for low elevations, the *vertical* target may practically be considered as coinciding with the normal one, the distortion being very small; and also that in many cases it is perfectly indifferent which of the three targets is used, inasmuch as having the positions of the shots on one, we can, if we know the *angle of descent* of the shot, easily adapt them to the others. Assuming as before the paths of the various shot, for this small distance, to be parallel, and the angle they make with the horizontal to be represented by θ, then we shall have, for errors in the direction of range,

Error on vertical target = error on horizontal target $\times$ tan θ ....(1)
Error on normal target = error on horizontal target $\times$ sin θ ....(2)

The errors in the other direction may, without sensible error, be assumed the same on all.

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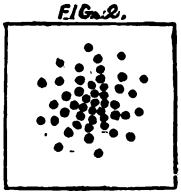
Suppose then, a normal target to be set up, sufficiently large to catch all the shots, and a gun to be fired at it a great number of times, with its axis always in precisely a similar direction. Assuming for the present, as the simplest case, that there is no tendency to err more in one direction than another, we shall find the marks distributed on the target somewhat in the following manner; that is clustered round a central point in numbers gradually diminishing as their distance from this point becomes greater.

FIG. 2.



The first thing to determine is the position of the central point. This is not directly shown by the shooting; indeed, it is quite possible that it may not exactly coincide with any one of the shots. It must consequently be found by calculation, and the laws of probabilities teach us that it should be in that position where the *sum of the squares of the distances from it to the various shots, will be a minimum;* and this is known to be the property of the centre of gravity of all the shots, which is easily found by well known rules. The point thus found is then, most probably,* the true centre where the gun, if it had *no error*, would deliver all its shot, and is therefore the point at which it may be said to be aimed. It is a very important element in all calculations of accuracy, and I shall call it the *centre of impact*, or *point of aim*.

Having determined this point, let us now endeavour to form some idea of the accuracy of the gun.

Perhaps the most obvious mode of doing this, would be to adopt a plan often used in comparing the accuracy of small arms, *i.e.*, to measure the linear distance of each shot from the central point (or what is called its *absolute error*); to add the whole together, and to divide by their number. The quotient will give a quantity which is popularly called the "*figure of merit*," or which may be more definitely termed the *mean absolute error*. This quantity will undoubtedly give some idea of the accuracy of the gun, for when we find the "figure of merit" to be less, we may rightly infer the accuracy to be greater, and *vice versâ*.

But suppose we are engaged on a problem which requires us to go farther, and to define *how much* better one gun is than another. We have no ground whatever for assuming the degree of accuracy to be proportional (inversely) to the mean absolute error. It may vary, for

* This probability being greater, in proportion as the central point is deduced from a larger number of rounds.—W. P.

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aught we know, as the square, or the cube, or the square root, or in no definite proportion at all. We can only say that a gun that makes a small figure of merit is a better gun than one which makes a large one; *how much* better, we have no right to pronounce without further reasoning.

To guide us in this reasoning, we must enquire, what do we mean by the accuracy of a gun? How do we define the term? To be enabled to answer this question, we must propose another. What is the object of accuracy? What use or duty of a gun is accuracy intended to promote?

To this there can be but one answer. Clearly the duty of a gun is to *hit the object aimed at;* and that gun will be most accurate which best performs this duty. And hence the *degree* of accuracy of a gun is evidently measured by the degree in which it promotes the efficiency of the gun in this respect. For example, if two guns are each fired 100 rounds, at a small object, under precisely similar circumstances, and one gun hits it 10 times, and the other 20 times, it is matter of common sense that the second gun will be twice as useful;—twice as well adapted to its duty;—in short, *twice as accurate* as the first one.

Now the number of times a gun will hit its object, *cæteris paribus*, in a large number of rounds, is equivalent to what mathematicians call the *probability* of hitting it, and hence we arrive at the conclusion that by the accuracy of the gun is meant simply the *probability* of its hitting the object at which it is aimed.

It is however necessary to the correctness of the definition that the object should be of *small size;* for of course if it were very large, a bad gun would be almost as likely to hit it as a good one. Any dimensions not exceeding the mean error of the best guns will answer the purpose in a practical point of view; but the principle becomes more correct when the object is reduced to an *indefinitely small area*, covering what we have called the centre of impact, or point of aim.

And hence the *probability of hitting this small area*, is the true scientific definition of the accuracy of the gun.

If now we turn back to our attempt to determine the accuracy of a gun by its "figure of merit," or mean absolute error, we shall at once see that this quantity of itself tells us nothing to the purpose; for it only gives the degree of average *proximity* to the centre, which by no means corresponds with the probability of hitting it. It is indeed possible, in some cases, to *deduce* the probability from the mean absolute error;* but as we shall hereafter show that there is a better method of finding this probability, of much more general application, we need not consider this "figure of merit" system further. It is merely a rough popular mode of estimation, devoid of any scientific

* If the error of the gun is equal in all directions, and l = mean absolute error, deduced quadratically, then the probability of hitting an indefinitely small circle of radius = dx, covering the centre of impact, will be = $\frac{1}{p^2} dx^2$, that is, the accuracy varies inversely as the *square* of the figure of merit. When the error is much greater in one direction than another, as is generally the case with ordnance, the method fails.—W. P.

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basis, and its use is unjustifiable where any scientific accuracy is required.

It is, however, worth while to add, that this system fails, like that of the probable rectangles, to give any means of comparing the accuracy of guns tried at different ranges. For it is evident that a gun fired at a long range will give a much greater figure of merit, and therefore appear much more inaccurate than one fired at a shorter range, even though the real accuracy of the first gun might be the greater of the two.

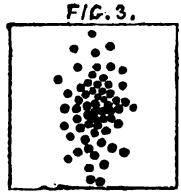
But there is a consideration not yet alluded to, which has an important bearing on the point now under discussion.

In describing the case above investigated, we assumed at the outset, for the sake of simplicity, that the gun had no tendency to err more in one direction than in another, and therefore deposited its shots in a circular form round the central point of impact, as shown in fig 2.

Now this is very seldom the case, for both theory and experience show that there is almost always a greater tendency to err in one direction than in another. It is true that many causes of error tend equally in all directions; but there are two important ones, almost always present in artillery practice, which act in one direction only. The first is, the variation in the initial velocity of the shot, caused chiefly by irregularities in the strength or burning of the powder, and which tends to produce *vertical* error on the normal target, or what is called "error in range" on the ground. The second is the disturbance of the position of the gun by the commencement of its recoil, which also acts in the same direction as the former one, the first movement of the axis being almost exclusively in elevation.

These two causes combining together, will tend to magnify the vertical errors on the normal target, and so to produce an elongated cluster somewhat like this figure.*

FIG. 3.



We have thus two different sorts of errors.

On the normal target they are simply errors in the *vertical* and *horizontal* directions respectively, as already explained.

* This peculiarity of figure in the practice of guns deserves more investigation. It might be easily inferred from the probable rectangles, if the angle of descent were ascertained; or the adoption of the "test target" system which I propose hereafter, would show it as a part of the process itself, without trouble. I am informed by Captain Noble that in some very carefully made experiments with a 12-pr. Armstrong gun, the variation in the "angle of departure" was about five minutes.—W. P.

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But on the ground, or in actual practice, they resolve themselves into what are called,—

1. Errors in range.
2. Lateral deviation.

The question has often been raised, which of these is the more important? but the differences of opinion among artillerists on this point, are so wide, as to admit of no satisfactory answer to it being given.

Some will consider error in lateral deviation, of more importance than in range; others just the contrary.

And this is only natural, when we consider the variety of objects for which, and the variety of ways in which, artillery may be used.

In firing, for example, at lines of men in front, lateral error is of less importance than error in range; but in firing at columns, or at the same lines in flank, the contrary is the case.

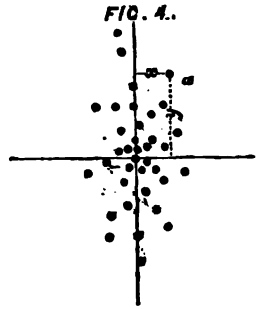
Also, in firing from a fort at a ship approaching or leaving, error in range is of less moment than lateral error; but in firing at her broadside on, the reverse is true.

Although, therefore, we cannot introduce, into our calculations of accuracy, any satisfactory comparative estimation of the two sorts of error; yet, the fact of their separate existence is very valuable for our purpose, inasmuch as it naturally points to another method of estimating the positions of the shot on the target, much more simple and appropriate than the clumsy method of taking their absolute distances from the centre.

This is the plan generally followed in mathematical calculations, whenever the positions of several points on a plane surface have to be considered, and called the method of *rectangular co-ordinates*, the application of which to the case in question is exceedingly simple and easy.

Having found the probable mean centre of impact as before (by taking the centre of gravity of the whole of the shots registered) draw through it a vertical and a horizontal line, as in the following figure.

FIG. 4.



Then, taking any shot *a* as an example, its position will be accu-

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rately defined by two co-ordinates, x and y, drawn parallel respectively to the horizontal and vertical lines before mentioned. We will call the distance y, the *vertical error* of that shot, and the distance x, its horizontal error.

Suppose next we wish to find the *mean* errors in both directions. The most simple and natural mode is to add all the vertical errors together (both above and below, without regard to sign), and to divide by the total number. This will give the mean vertical error; the mean horizontal error may be obtained in the same way. These mean errors are said to be determined *lineally*. They correspond with the "*écart moyen*" of the French artillerists, and we may denote them, in the French notation, by the symbols K and H respectively. So that

$$H = \text{mean horizontal error (determined lineally)} = \frac{\Sigma.x}{n} \quad \ldots\ldots(3)$$

$$K = \text{mean vertical error (determined lineally)} = \frac{\Sigma.y}{n} \quad \ldots\ldots(4)$$

But the term *mean error* is somewhat vague. A mean quantity is not necessarily a simple arithmetical mean; for the way it is advisable to find it, often depends on the purpose for which it is to be used. In this case, the whole problem being one of probabilities, mathematical considerations teach us that we shall have a greater chance of being correct, if we estimate the mean error in another way, viz., by adding together the *squares* of the separate errors, dividing by the number, and taking the square root of the quotient. The mean errors thus obtained are said to be determined *quadratically*. They correspond with what the French call the "*moyen écart*," and may be represented by h and k respectively,* thus

$$h = \text{mean horizontal error (determined quadratically)} \sqrt{\frac{\Sigma.x^2}{n}} \quad \ldots(5)$$

$$k = \text{mean vertical error (determined quadratically)} \sqrt{\frac{\Sigma.y^2}{n}} \quad \ldots(6)$$

Now having these mean errors, taken from a sufficient number of shots upon a normal target, we have all that is necessary for determining the accuracy of the gun; and, moreover, they possess the great advantage over the single absolute distance plan, that they show, of themselves, the tendency of the gun to error in the two directions respectively. It remains to point out how the probability of hitting the centre of impact (which we have stated to be the

* If the number of shots is not very large, it has been shown by Captain Noble that it will be more correct to divide each of the mean errors by $n - 1$.
If a very large number of rounds is taken, it is found that

$$\frac{h}{H} \text{ or } \frac{k}{K} = \sqrt{\frac{\pi}{2}} = 1{\cdot}25 \ldots\ldots\ldots\ldots \quad (7)$$

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correct definition of the accuracy of the gun) may be deduced from them.

In order to simplify the expressions used in the following somewhat complicated formulæ, we will make

$$p = \frac{1}{h\sqrt{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (8)$$

$$q = \frac{1}{h\sqrt{2}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (9)$$

p and q being called the "measures of precision" in each direction.

Assuming that there are no abnormal causes of error tending to produce special variations, the laws of probabilities give us the following theorem applicable to this case.

Taking first the horizontal errors; let us call an error to the right $+$, and an error to the left $-$.

Then the probability of a shot striking at a horizontal distance $= + x$ (see fig. 4), to the right of the centre line (or to speak more correctly between the distances x and $x + dx$), will be

$$= \frac{p}{\sqrt{\pi}} e^{-p^2x^2}\, dx \ldots\ldots\ldots\ldots\ldots (10)$$

And, similarly, for the vertical errors; let the errors above the centre be called $+$, and those below $-$.

Then the probability of striking at a distance $= + y$ above the centre, will be

$$= \frac{q}{\sqrt{\pi}} e^{-q^2y^2}\, dy \ldots\ldots\ldots\ldots\ldots (11)$$

The probability therefore of hitting a very small area of the target, situated as at a on the figure, will be the multiple of the two probabilities on which it depends, *i.e.*,

$$= \frac{pq}{\pi} e^{-(p^2x^2+q^2y^2)}\, dx\, dy \ldots\ldots\ldots\ldots (12)$$

Now suppose this very small area to be situated as at b, *i.e.*, close to the central point, making x and y each $= 0$. The probability of hitting it, which may be taken in practical language to be the same as that of hitting the centre of the target, will be

$$= \frac{pq}{\pi}\, dx\, dy \ldots\ldots\ldots\ldots\ldots\ldots (13)$$

and substituting for p and q their values in equations (8) and (9), the probability becomes

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$$= \frac{1}{2\pi hk}\, dx\, dy^* \ldots\ldots\ldots\ldots\ldots (14)$$

From which we see that the *accuracy of a gun is inversely proportional to the product of the mean vertical and horizontal errors, i.e.*,

$$\text{Accuracy of gun} \propto \frac{1}{hk} \ldots\ldots\ldots (16)$$

Supposing, therefore, several different guns to be on trial, we have here a means, scientifically correct and perfectly practical, of defining the accuracy of each, and of comparing them, in this respect, with each other.

But, to render the comparison accurate, they must all be tried *at the same range*, or nearly so.

For, of course, the probability of hitting a certain point, even with the same gun, must be much less at a longer than at a shorter range, and hence it is impossible to compare the expressions of accuracy obtained at different ranges.

I am not aware that any method previously proposed has provided for this case, but after a good deal of consideration I have suggested one which appears to me to answer the purpose. It is exceedingly simple, and is founded precisely on the same principles as the method above described, being merely an extension of them to a form of the problem somewhat more practical, and of more general application.

I propose to measure the accuracy of a gun by the *probability of its hitting*, not an indefinitely small area as hitherto assumed, but *an actual target*, to be called the *test target*, whose dimensions shall be *proportioned according to the range* at which it is to be used, in a mode hereafter explained.

For example: let it be required to compare the accuracy of two guns, one firing at 2,000 yds. range, the other at 3,000 yds. Let the former be directed at a target one yard square, and the latter at one *larger* in the proper proportions. Let 1,000 rounds be fired from each gun, aim being always taken precisely on the centre. Then if one gun hits the target 100 times (which a good rifled gun will do) while the other hits only 90 times, I propose to denote their relative degrees of accuracy by the direct ratios of these numbers, or as 10 to 9.

This mode approaches quite near enough to theoretical accuracy, while it has the advantage of being a kind of test of the most simple, practical, and intelligible nature, and one indeed which artil-

* Or making $dy = dx$; we may say that the probability of hitting a very minute square covering the centre of impact, whose side $= dx$, will be $= \frac{1}{2\pi hk} dx^2$. For a circle whose diameter $= dx$, the probability will be

$$= \frac{1}{8hk} dx^2 \ldots\ldots\ldots\ldots\ldots (15)$$

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lerists and riflemen are perfectly familiar with in every-day practice. And it has further the merit of being applicable to practice at any range.

I proceed to show, that in order to apply this method, it is not at all necessary that the guns should actually be fired at the targets as above supposed. It is quite sufficient that the practice be carried on in the usual way, by firing the guns at certain elevations, and registering the places of the shot as they fall upon the ground, precisely as usual. All the rest is matter of calculation, as from these data, the number of shot which *would* hit the targets, if the guns were really fired at them, can be deduced with even greater correctness than by actual trial. The only addition necessary to the usual elements given, is the determination of the *angle* of *descent* of the shot, which is by no means a difficult matter.

The most convenient form for the test target is a square; it must be supposed to be placed normally, and with its centre precisely corresponding to the centre of impact.

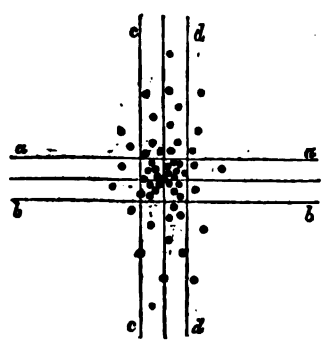
Let the length of its side, as hereafter determined,

$$= a.$$

The mean errors in deflection and range, having been determined (quadratically) from the shots on the ground, must then be applied to the normal target, the former unchanged, giving our quantity h; the latter multiplied by the sine of the descending angle to give k. The problem is then reduced to finding the probability of hitting a square target whose centre coincides with the centre of impact, and whose side $= a$.

To find this we must revert to the reasoning in Art. 21.

Let the following figure represent the group of shot referred to the normal position, and let the small square in the centre formed by the intersection of the four lines of a, b, c, d, represent the size of the *test target* we are now considering.



Taking first the errors in a horizontal direction, we have seen

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(Equation 10) that the probability of any shot falling between the distances x and $x + dx$ to the right of the centre, will be

$$= \frac{p}{\sqrt{\pi}} e^{-p^2x^2} dx,$$

whence the probability of any shot falling between the centre and any distance $= \frac{a}{2}$ will be

$$= \frac{p}{\sqrt{\pi}} \int_0^{\frac{a}{2}} e^{-p^2x^2} dx \ldots\ldots\ldots\ldots (17)$$

And, by the symmetry of position, to the right and left of the centre, the probability of any shot falling within the vertical band formed by the lines c and d (being a distance apart $= a$) will be

$$= \frac{2p}{\sqrt{\pi}} \int_0^{a} e^{-p^2x^2} dx \ldots\ldots\ldots\ldots (18)$$

Similarly, taking the errors in a vertical direction, we shall find the probability of a shot falling in the horizontal band comprised between the lines a and b

$$= \frac{2q}{\sqrt{\pi}} \int_0^{\frac{a}{2}} e^{-q^2y^2} dy \ldots\ldots\ldots\ldots (19)$$

And, since the probability of two events concurring is equal to the product of the probabilities of each separately, we find that

The probability of hitting the test target, and consequently the ACCURACY OF THE GUN, is

$$= \frac{4pq}{\pi} \int^{\frac{a}{2}} e^{-p^2x^2} dx \int^{\frac{a}{2}} e^{-q^2y^2} dy . (20)$$

the value of which for any given case may be easily found by tables constructed for the purpose.

It only remains to explain how the *size of the test target* should be determined for different ranges. This would require some little care at the outset, but being once correctly fixed, all difficulty ends. The conditions necessary are two-fold: first, that it shall be sufficiently small; and secondly, that its dimensions shall vary, for different ranges, according to what we may call the *march of precision* of the best guns; so that a gun of the most perfect kind we know may have an equal probability of hitting it at all ranges.

Our ballastic knowledge is not sufficient at present to enable us to determine this condition *à priori*, but it might easily be deduced from good records of the practice of the best guns, and a table might thus be constructed giving the size of test target suited to different ranges

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of fire. This might further, if necessary, be easily corrected from time to time as further knowledge was gained.*

This method of determining the accuracy of a gun gives a certain degree of preference to *compactness* of fire. If two guns firing at the same range, delivered their shot on the target in the manner represented by figures 2 and 3 respectively, both covering an equal area, but differing in the dispersive form, most artillerists would give the preference to figure 2, in which the fire was most *compact*. The test target system will show this advantage, as the probability of hitting a square target of definite size will be greater in the first case than in the second.†

I will now state the practical rule by which the "test target" method of determining the accuracy may be applied; having given, the fall of shot on the ground, and their average descending angle. It will be seen that it is very simple and easy.

(1) Find the mean range, and take out from the target table the length of the side of test target corresponding thereto, which call a.

(2) Find the mean error‡ in range, and multiply it by the sine of the descending angle. Call this k, and find the value of $\frac{a}{k}$.

(3) Find similarly the mean error‡ in lateral deviation, call this h, and find $\frac{a}{h}$.

(4) Having these two values, the accuracy of the gun may be found by simple inspection of an accuracy table to be constructed for the purpose.

* According to the information I at present have, I believe that the side in yards, of a test target, which will take one-tenth of the shot of the best guns, will be about $= \frac{r^{\frac{3}{2}}}{110{,}000}$, where r = range in yards.—W. P.

† The difference will increase with the size of target used at any given range. The disadvantage of want of compactness of fire is also shown by the "figure of merit" system, but in a much exaggerated degree.

‡ To be determined quadratically. If determined lineally they must each be multiplied by 1·25.—W. P.

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Evening Meeting.

Monday, January 21st, 1867.

REAR-ADMIRAL A. P. RYDER in the Chair.

NAMES of MEMBERS who joined the Institution between the 1st and 21st January, 1867.

LIFE.

Dawson, Hon. R. M. W., Lieut. Gren. Gds. 9*l.*

Sibthorp, F. R. Waldo, Lt. Col. Unatt, 9*l.*

ANNUAL.

Wood, Herbert W., Capt. R.E. 1*l.*
Strange, Alexr., Major 14th Regt. 1*l.*
Waugh, Sir Andrew Scott, Major-Gen., ret. f. p. R.E., F.R.S. 1*l.*
Frankland, Colville, Capt. 103rd Roy. Bo. Fus. 1*l.*
Hire, Henry W., Capt. R.N. 1*l.*
Fletcher, T. C., Capt. R.A. 1*l.*
Grubb, Alexr., Lieut. R.A. 1*l.*

BREECH-LOADERS, WITH REFERENCE TO CALIBRE, SUPPLY AND COST OF AMMUNITION.

By Captain J. H. SELWYN, R.N.

War Office, Oct. 22, 1866.

"To Gunmakers and others."

"THE Secretary of State for War is desirous of receiving proposals "from gunmakers and others for breech-loading rifles, either repeat- "ing or not repeating, which may replace the present service rifles in "future manufacture."

Such is the heading of the invitation addressed by the Government to all whom it may concern, and being myself one of these, I have thought that here, in the Royal United Service Institution, I might contribute to the general chances of success by reading a paper; for the discussion on it may perhaps establish certain bases of action, the want of which at present renders it difficult, if not impossible, for any one to invent, much more manufacture a satisfactory arm. If indeed

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we knew what calibre to choose or what cartridge to select, if the form of groove and the ratio of its spirality were not equally left undecided, we might think ourselves able to produce something that should fulfil the other conditions necessary in a perfect breech-loading rifle for infantry, at least we could certainly surpass without the slightest difficulty the so-called "Snider Rifle," (Plate I) which is, in the circular, proposed to us as a model. But who can compete in a race where important conditions are not precisely stated, and where the winner might be told he was disqualified because he had not got on high heeled boots, or his horse had not been shod with gold; neither of which conditions were previously within his knowledge. But whether or no, all these points are said to be "optional," and we must seek for ourselves, the explanation of that word "optional." It will be evident from even a cursory examination of the subject, that on the calibre must depend a considerable proportion of the other conditions, and therefore the very first question to be solved is this, what is the best calibre of bore, and consequently what will be the size and shape of bullet? I confess that I incline to ·500 of an inch, as the best compromise between unnecessarily large and unwisely small bullets. Now as the bore of a breech-loading gun should always be smaller, over the lands of the rifling than the bullet, that is that the ·500 of an inch should be measured from the bottoms of the grooves, it follows that the calibre as usually measured will be something less than ·500, less in fact by whatever may be the depth of the grooving. In a breech-loading gun the idea of expanding bullets is unnecessary and ought not to be retained, unless it be merely a consequence of the fulfilment of other important conditions. No alteration of the shape of the projectile should be allowed to take place, whether by upset or expansion, if we wish to obtain regular shooting. It is, however, a not unimportant consideration, whether, unless we can secure a materially lighter bullet, it is worth while for the sake of long range alone, to alter in any way the present calibre. Long range for military purposes will lead to the waste of much ammunition. I doubt whether it will ever decide the fate of a battle. A change of calibre will introduce still greater confusion and difficulty where there is too much as it is, *i.e.*, in the supply of ammunition; besides the teaching of the late war in Germany, does not seem to be favourable to the theories of those who advocate the small bullet. If indeed we could by using a smaller calibre, materially diminish the weight to be carried, this would be an object worth attaining, but the small-bore bullet weighs as much as the Enfield when made of such a shape as to give its best results, and if lightened by admixtures of substances of less specific gravity, its range and penetration cannot be so great. There is indeed a form of bullet which seems likely to meet most of the objections that have hitherto prevented us from obtaining a perfect projectile. This is the Macintosh tubular or hollow projectile, of which I shall speak more fully in its place. The first question I should wish to be solved by the discussion is this, if we reduce our calibre with what view are we to do so? Is it to be done for the sake of a long range, which Military and Naval Officers will alike tell you is a secondary consideration in

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the field, or for the lightening of the bullet in order to make it possible for the soldier to carry more ammunition. Secondly, how far can we go without reducing the efficiency of the ball at those ranges where it is most generally used in warfare, unless preserving the same outside diameter, we reduce the specific gravity by admixture with tin, wood, or air, as in a bullet more or less hollow. I am myself in favour of the latter.

It will be useful to recollect that the whole question of grooving has been re-opened by the use of breech-loaders, and that a fine grooving which would have speedily been inoperative by reason of fouling in a muzzle-loader, will probably give excellent results in breech-loading guns, where the bullet is at once forced into the grooves through its whole length by the explosion; and fouling is scarcely perceptible after any number of rounds if the lubrication is properly managed.

The question as to supply of ammunition in the field comes next in order, but this is so closely united to the question of calibre, that what answers one will solve the other. Nevertheless, we may observe that the mode of supplying ammunition in the field must vary with the nature of transport in different natures of ground. Men in mountainous countries, mules, horses, or elephants in less difficult circumstances being used as each is found available. Although it is said that no soldier, during the late campaign in Germany, was short of cartridges with an original supply of 60, this must not be taken for a rule, seeing that our own experience in the Crimea and elsewhere has shown conclusively that it is sometimes insufficient, and that 100 or 120 cartridges would be more desirable as the normal number to be carried by the soldier. In most forms of cartridge now known, the smaller the calibre, the more unhandy and expensive is the cartridge on account of its increased length.*

I now come to the cost of the cartridge, and this is of the first importance, seeing that with a difference in this respect of £1 per thousand, the fourth thousand will have cost more in excess than the best guns which can be made for about £3 10*s.* or £3 18*s.*, and this will go on telling during the whole life of the gun, a specially interesting fact to volunteers, who probably now fire more ammunition in the year than our whole army, and what is more, have to pay for a good deal of it themselves. We may take the average price of powder and ball for an Enfield rifle at 35*s.* to 40*s.* per thousand cartridges; and the cost of each description of case, is of course the difference between this and the selling price of the cartridge per thousand. The cartridge now used for the converted Enfield is sold by Messrs. Eley, at

* It seems to us Naval men, that a great economy of the weights a soldier now carries, might be made by improvements in dress and accoutrements; that a cartouche box is an absurdity only inferior to the old shako, and that thus the men may be enabled to carry 120 cartridges, which would weigh about 12 lbs. No system of supply, is equal to that of carrying what is essential, about one. We must also recollect that old Brown Bess weighed 12 lbs., the modern rifle, only 9 lbs.; and as the 60 cartridges now carried weigh about 6 lbs., or 10 to the pound, we only ask for 3 lbs. more to be carried than the regulation weight of arm and ammunition during the Peninsular War.—J.H.S.

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no less than £5 per thousand. I cannot say what it may be quoted at at Woolwich or Enfield, seeing that at the Government establishments, and in Government calculations generally, nothing is charged for capital, salaries, or manufacturer's profit. But £5 per thousand is an almost prohibitive price to the Volunteer of moderate means, and will sadly curtail his inclination for practice at the targets. The composite cartridge known as the "Boxer," is seldom capable of being refilled, and therefore the whole of the first cost must be charged against it. The great desideratum is a metallic cartridge which shall weigh no more than, and cost as little as, the old powder and ball, while possessing that immunity from damage by fire or water which is the characteristic of the copper-cased cartridge, and with this, that the exploded case should either be easily extracted, or that there should be no need for this process. I have here an invention which seems likely to fulfil these conditions, and in addition to them, possesses some most valuable qualities of long range and low trajectory. Having made these preliminary remarks, I propose to classify the different forms of cartridge and bullet; to bring before you the peculiar properties of each; and then to pass in review, in a similar manner, the best known arms from which they are to be fired.

The cartridges for breech-loading fire-arms may be broadly divided into three primary classes:—

First, the paper or skin cartridge.

Second, the composite cartridge.

Third, the metallic cartridge.

The paper or skin cartridge may, or may not be self-igniting, its price is about 40*s.* or 45*s.* per thousand, it is easily destructible by wet or fire and liable to be exploded by shells, when in ammunition reserve waggons. The Prussian needle-gun cartridge and the Mont-Storm skin cartridge are good examples of this class. It will probably disappear from warfare, and does not therefore require further notice.

We now come to the composite cartridge and our examples may be taken from the sporting cartridges, whether central-ignition, or pin, and that used for the converted Enfield called "Snider's" rifle.

We have here an enormous step in advance. The breech-loader, which before the introduction of these cartridges, was liable to the serious objections of bursting, gas escape, and fouling, at once becomes a safe and cleanly weapon. But in both of those referred to, and indeed in all cartridges that are indestructible by the explosion, a serious difficulty has to be met, viz., that of the withdrawal of the emptied case. This is in most cases accomplished by an extractor, a special appliance moved by hand, by springs, or by levers, which cannot of course act properly on any cartridge, that by sticking, offers unduly increased resistance, or by bending or breaking, offers too little. These disadvantages have already been seriously felt in many cases with both the composite and metallic cartridges, and any weakness of the cartridge is sure to make itself evident in this direction. The composite cases are not all as yet, though probably they easily might be thoroughly protected from the effects of a damp atmosphere, and this

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leads to "sticking" more often than would otherwise take place. The selling price of these cases, empty, ranges from 60*s.* per thousand (military Boxer's) to 40*s.* and 20*s.*, for sporting purposes; but a well known gunmaker has told me that the paper cartridge with metallic base, for military purposes, can be sold *filled* for 55*s.* per thousand. This seems a very low price, being only 15*s.* per thousand for the cases! and it ought to be good news for sportsmen and Volunteers if correct. In both the sporting and military composite cartridge, the ignition is effected either by central fire or pin; the central fire is in almost every respect, the preferable mode, and though it is true that the pin cartridge shows when the gun is loaded, which the other does not, yet it is easy to meet this objection, and it has been done by various contrivances; while a considerable gas escape which takes place round the pin is a much more important fault. For a military gun of moderate bore, a serious loss of space or increase of length, is the result of using a material like paper or pulp to which a certain thickness is necessary to be given, and although this is not the case in the brass roll cartridge, yet its want of solidity is an almost equivalent evil. This latter cartridge must also be more expensive to manufacture than simple metallic ones, and it is hard to understand what advantage it possesses above the less complicated American cartridge. I look upon the withdrawal of the empty cartridge case as quite as easy in all cases, whether a rolled sheet or a stamped cylinder is used, both expand to the form of the barrel. This is always coned out to the rear in the chamber, a practice which can only be defended as being necessary for extraction, and one that is directly opposed to all the laws of gunnery, but it no doubt does permit the withdrawal of the exploded case with a facility not otherwise attainable in this form of cartridge.

I will now pass to the third class of cartridges, those constructed wholly of metal and stamped up from blanks by machinery. There is a simplicity and speed of fabrication in these that is very attractive to the manufacturer and I shall have some curious varieties to show you. The strength and non-liability to injury by fire or water, together with the fact that in some forms the exploded cases can be many times refilled, and at last are saleable as old metal, will tend also to make them favourites with the shooter. I believe the origin of the American form which is the best known, was the breech-loading bulleted cap of the saloon pistol and rabbit rifle. However this may be, the Americans seem to have at once adopted it for all their breech-loading guns, and although not the cheapest, the metallic is certainly the most durable cartridge under all conditions. Even the white ant could do it no harm and powder may be ignited all round it with impunity, whilst if the bullet and cap be well waxed, it may be kept in water for months and then fired with perfect certainty. The American metallic cartridge is generally, if not always, ignited by fulminate placed in the rim surrounding the base, but this system has the defects of causing an excessive quantity of fulminate to be used which sometimes blows through the base and gives dangerous gas escape, at the same time that it renders difficult or

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prevents the withdrawal of the case by the extractor. I have been told by an American that the price of these cases would be about £2 per thousand, the cases with the rim priming are difficult to refill, and would be worth, as old metal, about 10*s*. per thousand.

Modifications of this form have been made in America, but are not I believe now in use. In this country the Poulteney cartridge, a double cone, and Mr. Clark's steel or iron cartridge are variations on the common form, but I cannot say to what trials they have been subjected. There is also one that is known by my name, which has the peculiarity that it is self-extracting by the expansion of the copper into depressions or annular grooves in the barrel, and that by reason of its conical form the *primed cases* will pack one inside the other, enabling 6,000 to be stowed in one cubic foot, whereas only about 1,800 of any others can be so stowed. It is also considerably cheaper to manufacture than cylindrical copper cartridges and can be refilled five or six times. The next metallic cartridge to which I shall draw your attention is a novel and very ingenious invention of Mr. Macintosh's. Here the case is of lead, tubular in shape, open at both ends, having the weight and diameter of an Enfield bullet, but 1·77 inch in length. A wad of wood or other material carrying the means of ignition is secured by a covering of thin felt behind the tube, it is then filled with powder and the cartridge case has become also the bullet and a very efficient bullet too, having a point blank range of 400 yards, and an extreme range much greater than the ordinary projectiles owing to the diminution of the area of resistance. By reference to the diagram (Plate I.) you will see that these projectiles are fired by first shaking out the powder from one of them and placing it in the gun with its wad; next, another is inserted *with the powder*, and this pushes the first up the barrel. The breech being now closed and the gun being fired as usual, the first inserted bullet is driven out, and the second remains ready to be in its turn pushed forward, from having been a cartridge case to become a projectile. Some experiments have been made and others are in progress, and I shall be happy to communicate the results on some future occasion. You will see that although I hoped I had made as good, if not a better, metallic cartridge than any other, yet if this be a true system, no other metallic cartridge can compete with it, and mine must become obsolete with the others. A still farther advance has been made by Mr. Macintosh by the discovery of a new explosive compound, which he states is perfectly manageable, and so reduced in bulk as that the full charge can be contained in the base of an ordinary Enfield bullet. I have now I believe given sufficient material for a discussion on the best form of Cartridge, and though I am aware that the subject is far from being exhausted, I think it is time to turn to the arms.

It would clearly be impossible in the limits of such a paper as this, to speak of every variety of Breech-loader, and therefore I have found myself compelled to arrange them in classes, in defining which, the two main divisions seem to be, the existence of a solid or hollow breech-block or chamber. Under the head of solid breech-blocks we find the Prussian; the Chassepot; the converted Enfield; the Needham;

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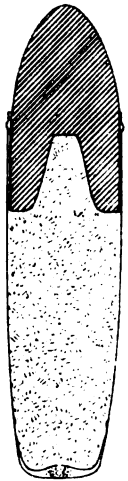
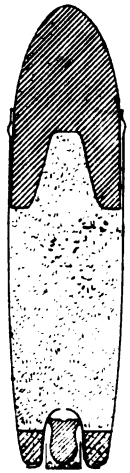
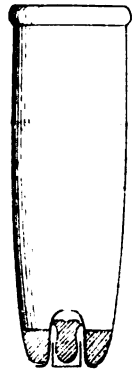


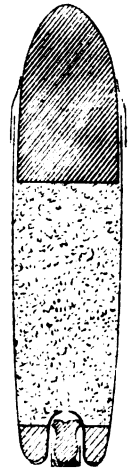
Selwyn Cartridge
modified



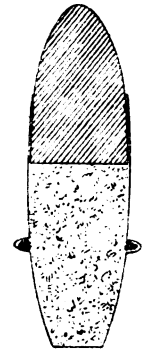
Selwyn Cartridge
as now made



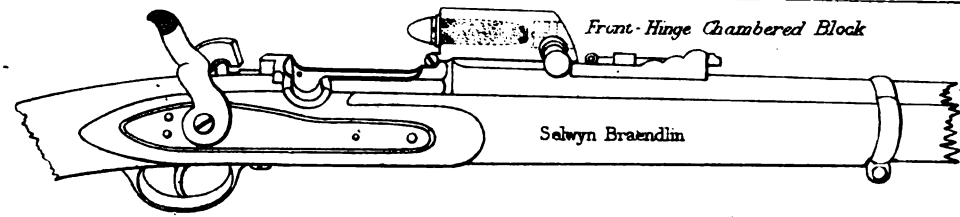
Selwyn Cartridge
after explosion



Selwyn [illegible] Bore
(Punch) Cartridge



Poultney Cartridge



J. Jobbins

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the Albini Braendlin; the Peabody; the Berdan; and a host of others of greater or less merit, most of which would fire and extract the so-called Boxer cartridge much better than the "Snider." Under the head of hollow-chambered guns I find the Mont Storm, and the late modifications of it, which fire self-igniting cartridges; the North; the Lechmere; and some few others. While it is not my intention to go into the distinctive merits of each of these guns, there are certain principles which may fairly be the subject of remark. I have already adverted to the fact, that all the solid breech block guns which are made to fire a cylindrical cartridge, are of necessity coned out to the rear in the chamber or seat of the cartridge. It is also an evil of this form, that two inches or more of the gun is sacrificed, and that in every case some form of extractor is necessary. When to these necessary evils, are added such complications with spiral springs and sliding motions as exist in the converted Enfield, we are at a loss to conceive why the more simple forms of solid breech-block should be passed over, why work should be thrown on the hand which in other systems is better done without any separate motion, and what durability can be predicted for such generally clumsy contrivances. Very few indeed, out of the many forms of breech-loader proposed, would withstand an Indian dust-storm, or a Sydney "brickfielder." Sliding bolts and sliding surfaces generally, are especially liable to this objection, and also in common with spiral springs, are to be eschewed in all arms intended to be subjected to sea-air. Strength, simplicity, and cheapness are only to be attained by a right understanding and a faithful following of correct principles, and a sacrifice of these to expediency, will be sure to punish itself. There is another form of breech-loader still remaining to be noticed, namely, the magazine gun, which is full of ingenuity, springs, and levers. Those of this class that are only magazine guns, that is, fire a limited number of shots from a receptacle where they are stored, though very attractive to the uninitiated, are not capable of giving more rapid fire in the long run than an ordinary breech-loader which, like many of these, will fire 16 or 17 shots per minute. It is only where combined with a power of loading and firing single shots, that the magazine becomes of practical utility, and even here as the weight is constantly varying —and would be excessive in a full-sized infantry arm—the conditions are not favourable to accurate shooting. Add to this, that the dust storm would here be especially dangerous, and I think it will be evident that however applicable it may be for cavalry and artillery, the magazine gun does not yet take rank as a serviceable weapon for infantry.

I cannot conclude without drawing your attention to a most interesting early breech-loader from the Museum of this Institution, which arm in 1661 seems to have been made by an Italian genius. With all the difficulties of a flint lock and loose powder and ball, it accomplishes self-priming and fires it is said 20 shots per minute.

One of the guns using the Selwyn cartridge has been fired during the day by an attendant of the Institution and I will now show you how the cartridge draws itself after explosion. It has been kept,

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since being fired, without opening, and as the effect is not easily understood, I have thought this the best mode of showing the action. I have only further to express my thanks for your patient attention, and to hope that the discussion will be conducted in the true spirit of scientific enquiry, with united good feeling in the pursuit of a common object.

Captain HORTON, R.N.: I should like to ask Captain Selwyn a question. Has it been ascertained throughout what distance of range the Macintosh projectile maintains its straightness of direction? You have kindly shown us an illustration of a short distance, but I should like to know how far the straight line of flight has been traced.

Major-General BOILEAU, F.R.S.: I had hoped to have heard some observations from professionals on the very interesting paper which has been read by Captain Selwyn, but presuming that they are gifted with more modesty than an old soldier is supposed to possess, I purpose to break the ground, and I hope the few observations I have to make—and they will necessarily be very few, for Captain Selwyn has really exhausted the subject—may lead to such further discussion of this interesting and most important question as will secure to the Government, as I believe it has already secured to it in another branch of arms—the artillery—a modification of the principles, which had been introduced to the prejudice, I think, of the interests of the Service, and to the introduction of other principles, which are now standing us in good stead. With respect to the calibre, I agree with what Captain Selwyn has said. I believe the half-inch calibre is the best that can be adopted. I have tried rifles of the several bores usually made use of, both among Volunteers and for long-range shooting, and I think the half-inch bore produces on the whole the most satisfactory results. The bullet may be made sufficiently light to be carried in greater numbers than the Enfield bullet, and sufficiently long to give good practice at ranges as great, probably, as will ever be adopted in practice in the field, namely, from 800 to 1,000 yards. It is not necessary, as Mr. Whitworth has proved at Woolwich, to have a small bore for accurate long-range shooting, for bullets of the Enfield bore have produced as satisfactory results at 1,000 yards as the small bore, a slight increase in weight only being given to them. There appears to me to be another advantage in not making the calibre too small. It is this, that if barrels are retained of the same exterior form, and rifles are retained of the same length as the long Enfield, the smaller the bore the heavier the rifle becomes. Therefore to make a rifle of small bore as portable and as handy as one of large bore, you require either to make the barrel thinner, which will make it weaker, or to make it shorter, which has also its disadvantages. These are reasons which may fairly be assumed for giving preference to the half-inch calibre which Captain Selwyn has adopted. Then, as regards the form of the breech apparatus, I have myself generally preferred the plug or piston system; that is, the system in which the plunger acts in collimation with the axis of the barrel, as having certain advantages over all other forms, especially in that freedom from obstruction in dust-storms and the adverse circumstances which affect others. Those objections are particularly applicable, I think, to the Snider rifle. And I must say, after having most carefully examined the several specimens of Captain Selwyn's rifles which have been exhibited this evening, and which we have had an opportunity of examining in detail in our Museum, I am almost, if not altogether, a convert to the principle which he proposes to introduce. I think there is this very great advantage in it, the entire absence of all springs and such appliances, which might in service make the piece absolutely useless. There is no disguising the fact that an opinion has got abroad, and I must suppose it to a certain extent to be founded on fact, that the Snider rifle, with the Boxer cartridge, is not a success. I will not say it is altogether a failure, but it has in so many instances been found that the cartridge case cannot be extracted, and that the rifles sent out for service have to be returned to the factories to have the cartridges extracted from them. I say if that be true, it is a fact sufficient to condemn the principle altogether. I never myself had any opinion of it, from the circumstance of its complication, and from the fact that unless the cartridge is pushed quite home, and both ends of the block-piece are

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free, it is possible that the closing piece or breech block could not be so brought down that the rifle could be fired. An objection has been made to breech-loading apparatus on the principle which Captain Selwyn proposes to introduce, *i.e.*, with a chamber of a certain dimension, namely, that you can only place a cartridge with a given charge of powder in it, and that, therefore, where a greater or less quantity of powder is required, the system would not be satisfactory. That may be very well for practice at long ranges at a target. But I think a rifle for use in the field ought to be so constructed as not to require two forms of cartridge under any circumstances. If we may assume, and I believe experience in the late wars has given us ground for assuming, that battles will be fought at *short* ranges and not at *long* ranges, then I say the objection to the cartridge being made capable of containing only one quantity of powder vanishes altogether. I may say also that the design of the breech apparatus appears to be simple, and not to have that objection which I referred to on a former occasion in this Institution in respect to the Mont-Storm rifle, namely, the heat of the breech causing the cartridge to explode prematurely. To hold the piece, as Captain Selwyn suggests, at the port, it may be loaded with the most perfect safety, while the copper case protects the cartridge from the heat of the barrel; the great objection which existed to the Mont Storm pattern of breech-loading rifle is thus obviated. I have made these few observations merely to break the ice in the discussion of this interesting subject, and to confess that I have been made a convert from a principle which, up to the present time, I believed, had been the best introduced, viz., the plug or piston system, to one which I have no hesitation in saying, as far as without experiment one is able to judge, the best form of breech-loader that has yet been brought before the public for the use of copper-case cartridges.

Captain G. V. Fosbery, V.C., H.M. Bengal Army: I have only one objection to make to an observation made by the lecturer. It is the wholesale condemnation of every arm which contains a combination of spiral springs. I hear the same objection made to all arms made on that principle by the principal gunmakers of Birmingham and London. But I cannot help recollecting that 240,000 men went into a campaign last year, the mainspring of whose weapon was the spiral spring. The efficiency of every arm carried by every soldier of that army consisted in the spiral spring. Therefore I think the objection to any arm containing a spiral spring requires some little modification; the wholesale condemnation of them I cannot agree with. Further, when one speaks of the impossibility of men carrying two sorts of cartridges, it should be remembered that the whole system of musketry instruction divides men into two classes, the men who can shoot and the men who cannot shoot. The man who can shoot may carry a special cartridge, with a special charge of powder for a special weapon; and the second class man may carry either the double bullet cartridge, or some form of cartridge intended for short ranges.

Commander Colomb, R.N.: I should like to say one word as to the deterioration of spiral springs. I have an apparatus which is used on board ship. When first it was introduced I was obliged to use some spiral springs in it. I used thin steel watch springs; I found that these lost their vitality very quickly indeed. I then substituted brass spiral springs, which, I presume, the meeting will allow, are more likely to stand sea air than steel spiral springs. I still found that these springs deteriorated from the action of the sea air in a way that very much surprised me.

Captain Selwyn: Gentlemen will perhaps recollect that my observations only applied to the effects of sea air.

Mr. G. H. Daw: Having devoted many years to the subject of cartridges and breech-loaders, I have listened with great interest to the words from our lecturer, and I agree with him in many points. But before the Government decide upon the half-inch or small bore cartridge, they should well consider the matter; because if the cartridge used is one to be withdrawn, the case must be extended to such a length, that to a very considerable extent the part forming the breech will be weakened. There are many essentials necessary in a breech-loader; and unless a gun embraces all the advantages or wants of a military weapon, it will soon fall through from weakness, where it ought to have the most strength. I have tried all lengths and all forms of cartridge, and I certainly find that the present size of the Government cartridge is preferable for withdrawal cartridges. It carries the charge of

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powder that has been almost universally adopted within the last few years; it gives a less length to withdraw; there is less liability to crack or stick than there would be in a longer one. The half-inch to carry the full service charge, whether the cartridge be metal or paper, has certainly many disadvantages. It has been found by those who have experimented in England, and also in France, at the present moment, that they are obliged to abandon many of their wishes with regard to the small bore, simply from the cause, that the cartridge, if it is withdrawn, is liable to split, or jam, or the rear end to be torn off. If we decide upon a change of cartridge, I have no doubt that the half-inch will be found to have many advantages. But speaking up to the present moment, I think the present gauge, taking the present bullet with the cartridge now in use, is preferable for many reasons, which I need not now detain you with.

Major-General BOILEAU: Will you permit me to make one observation with reference to what Mr. Daw has said? I respect him as a great authority upon the subject, but, perhaps it did not occur to him that in Captain Selwyn's form of breech piece, the same breech-piece suits any calibre. Therefore, a cartridge for a small bore is just as easily withdrawn as a cartridge for an Enfield bore. The breech-chamber and the cartridge are separate, and may be applied to rifles of any calibre. It is only by a contraction of the fore-part of the copper case, so as to make it fit bullets of different calibres, that the application to different rifles exists, all the other parts of the rifle are the same. Therefore with reference to any rifle which acts by a plunger, and in which the cartridge is first pushed into the barrel, and then extracted afterwards, the observations which Mr. Daw has made are perfectly correct, but I think they do not apply to that peculiar form of Captain Selwyn's breech-piece, which is applicable to any calibre whatever.

Mr. DAW: I think it would be preferable, even on Captain Selwyn's principle, with which I am well acquainted, to adopt the present size, because the breech-block would be shorter, and that part forming the breech would be considerably stronger. A military man may use his weapon in a very rough manner; and the larger the part to open for the cartridge, the more liable it is to be put out of order.

Mr. JOHN LATHAM (Messrs. Wilkinson and Sons): I would only make one observation which bears upon what Mr. Daw has mentioned. He speaks of "the usual service charge" which in this country is generally accepted to be from 70 to 75 grains. I have examined a great many of these new American arms which have been sent over, which are very ingenious, and very pretty in their action and mechanism. The only thing is, that they excite some misgiving as to whether they would work in action. But I find on careful consideration, that in the cartridges sent with them, the proprietors usually send charges of powder varying from 40 to 48 grains. When we consider that in England a service charge is considered to be 70 grains, and that in our proof, the gun which is to be fired with a 70-grain charge will have to stand a charge of 100 or 120 grains, I think we see why the Americans are able to be a great deal more ingenious and clever in their contrivances than we are. I think that the reason why there has been so little discussion upon Captain Selwyn's paper, is simply this, that Captain Selwyn has left so little to discuss. He has gone so clearly and plainly into the principles, that the majority of his hearers certainly must agree with him on every point. With reference to his own plan, it certainly possesses a merit which is very uncommon indeed in the plans of the present day —that is, *originality*. By making the powder serve as the extractor, he saves an additional piece of mechanism, and introduces us to an idea, which I trust has proved successful in his own modification of it, but which certainly is a new and very valuable one, because, as far as I am aware, it has not been applied in any other arm to a metallic cartridge. The conical form also which he adopts, he has very clearly explained to us. As we all know, it is theoretically the best form, and that which we lose in every other form of cartridge. We get in his conical cartridge the advantage of the patent breech, the improvement which was made by Henry Nock when he introduced the patent breech, and the advantage which was introduced in the Gomer mortar. I have now to point out as a very curious circumstance, that the plan of opening and closing the breech which has been adopted in the Snider rifle, is absolutely the very earliest to be found in England. In the Tower of London at

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the present time there exists a breech-loading gun, a short gun, of the time of Henry VIII. (Captain TUPPER: A matchlock gun?). Mr. LATHAM: A matchlock gun, which has precisely the same method of opening and closing the breech, as the Snider gun, with a separate pan for the priming, which is fired by the matchlock in the ordinary way.

Mr. DAW: Will you allow me to say that if you look at the American cartridges which have been brought over, you will find that the ball is much lighter than that in ours, and that those cartridges vary in the charge simply for this reason, that some are for carbines, the others for muskets.

Captain SELWYN: I am extremely sorry to find that what I had regarded as merely raising points for discussion should have been accepted as anything more than what I intended it for. I am here, like everybody else, who is not a professed maker of artillery, as a learner; and I did think that this discussion might have been utilized as a means of telling us what neither the Government nor any individual can tell us. I can scarcely believe that any feeling of jealousy can apply in such a case, for it is merely the basis of the principle which each man carries out in his own way. And I did abstain from mentioning as much as possible anything that I had done in order not to encourage other people to think that it was necessary for them to defend their own views; but only that it is necessary for all of us to understand on what principles we are going to act. The question put by Captain Horton, through what distance the Macintosh projectile has been tried, can, I think, be answered by Mr. Macintosh himself, who is here present. I have not tried it through any distance myself, but he has tried it from a smooth-bore musket, and he will tell you the results as to range.

Mr. MACINTOSH: The reason for getting a superior range with my new projectile, with the same driving charge over the Enfield bullet, exists in its being a hollow tube. After the projectile leaves the gun, the wad from its lightness recedes before the column of air which passes through the cylinder; the air passing through, obviates in great measure the resistance in front of the projectile, and also the vacuum formed in the rear, which takes place in other bullets.

Captain SELWYN: Captain Horton's question was as to what range you obtained.

Mr. MACINTOSH: The range was 300 yards more than that of the Enfield bullet.

Captain SELWYN: With the same charge?

Mr. MACINTOSH: With the same charge.

The CHAIRMAN: What was the total distance?

Mr. MACINTOSH: I think it was 600 or 700 yards, I forget which.

Captain SELWYN: The same elevation?

Mr. MACINTOSH: The same elevation.

Captain HORTON: Another of my questions was whether it reached its destination without turning?

Mr. MACINTOSH: It did. The bullets which are represented on the board are smooth in the inside, and also on the outside. They are intended to be fired through a rifled barrel. You perceive that when the charge is exploded, the bullet expands and forces the metal into the grooves, consequently it is then dependent for its accuracy of flight upon the spin which the groove gives it. There is another advantage which I have found in using a bullet of that sort, that is, you can have a large exploding chamber in which your gas is thoroughly ignited. This causes the greatest amount of useful effect to be obtained from the quantity of powder discharged. With regard to the sabot that has been proposed, you use a small projectile and a large bore, and make up the difference of the diameter with the sabot. You have there a difficulty which in using my bullet is overcome. In using a smaller projectile it has been proposed to wind some light material round the exterior of the projectile, so as to fill up the bore; and it is supposed that in passing through the air that will come off. However, I think this would be very ineffectual. In this case you use a large projectile with the same useful effect, in consequence of the interior of the bullet being hollow. The advantage gained is, that you give a large amount of work or a high velocity to the projectile, with but comparatively little pressure of the powder gas, whilst lessening the atmospheric resistance. In reference to the means of ignition, the fulminate is put in a recess of the wooden plug, or wooden wad, the same as in any other central firing.

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Captain SELWYN: General Boileau remarked, certainly more favourably than I expected, on the system which I advocate, when I am not employed as now, in reading a paper on the *general question*. He also remarked that there was an idea that a cartridge could not hold any charge that is required, that its charge could not be changed. Now in the so-called "Boxer" cartridge you will find cotton behind the bullet. People have said, "It is useless, this cotton." It is not so; it does contribute very considerably to the cleaning of the gun. And that cotton may occupy any space that is not occupied by powder; therefore, there is no difficulty in firing any charge from the same case. Captain Fosbery will be kind enough to remember that the whole of my words apply to the necessity for not using spiral springs at sea. Now, as naval rifles do see a great deal of service in the course of the year, in peace or war, we do think it is of the utmost importance that when they are specially intended for a salt-water atmosphere, and exposed to being washed with salt water occasionally, the springs should not, the first time we allow the hammer to descend upon them, give way, and necessitate Jack taking out the nipple before he can get in a new spring. I am afraid he has not patience enough to do that under fire; he is much more likely to throw the rifle at the head of the first comer. The army have chosen their artillery, the multi-groove breech-loading Armstrong; they have chosen their rifles. I do not think either of them will suit us at sea. With regard to two classes of ammunition being employed, there is not the slightest difficulty in doing that, if it is so desired. I have shown the form of cartridge which is adopted whenever a small bore is desired. The cartridge is then made in two parts, but the act of explosion connects them indissolubly together; so they are drawn as one, the joint of the copper coming just at the point of the annular ring, or the depressions, which I rather prefer. Captain Colomb's observations were, I think, confirmatory of my own experience with regard to spiral springs at sea. Mr. Daw spoke of the extension of length in the small-bore cartridge, which certainly is, as far as I have yet known, perfectly and accurately true of the cylindrical cartridge. But the same observation on this subject applies again to his views. When we speak of the Selwyn cartridge, no greater length either of breech-piece or cartridge is then necessary. Mr. Latham was also pleased to be extremely complimentary, for which I thank him most heartily; but I would rather hear from a man who has paid so much attention to the subject, some distinct expression with regard to the value of long range—something from which we can deduce the bore which we are to keep—something which may, indeed, advance not only my views on the subject, but those of every one who comes to this Institution. For I think the arms we see around us are a sufficient proof of the attention paid to the subject in the Institution; and that we are, if the members of any Institution are, fit depositaries of the principles of artillery and gunnery. These discussions have had, on very many subjects, most extended usefulness; and I have reason to know that they are viewed with very great respect by Governments abroad, and increasingly so by our own Government. Under these circumstances, I think I was not unwise in inviting the co-operation of the gun trade, whose interest is closely connected with the resolution of all these questions. I only hope that some one may read another paper on the same subject, which may be more successful in bringing out those views and those opinions on principles that will be of so great value to the whole country.

Major-General BOILEAU: I have to return my best thanks for the explanation which has been given of the method of charging cases with different quantities of powder. It is another instance of the advantage of cotton, and of the many and varied uses to which this material may be applied, one of which, in the case in point, adds force to the old saying, that cotton never can be worsted.

The CHAIRMAN: I am sure that you all wish me to return your thanks to Captain Selwyn, for the interesting paper he has given us. It has been suggested to me, to state for the information of those who may not be aware of it, that the rifles you see upon the table are from the collection in the Institution; and also that there are several others there which have not been brought down into the theatre. If there are any gentlemen present, inventors of new rifles, I should add that we shall be happy to receive any specimens they may be good enough to send us.

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LECTURE.

Friday, February 1st, 1867.

COLONEL SIR T. TROUBRIDGE, Bart., C.B., D.A.G., in the Chair.

ON THE BEST MODE OF RECRUITING FOR THE ARMY.

By Captain NOAKE, Adjutant, Scottish Borderers Militia.

I AM SO deeply sensible of the extreme importance and difficulty of the subject on which I am to have the honour of addressing you this afternoon—How to Recruit our Army being, I may almost say, the problem of the day—that I must at the outset bespeak your indulgence for any shortcomings on my part. Nothing could have induced me to come forward on the present occasion but the deep interest I have for many years taken in the soldier's welfare, and the hope I entertain that my humble suggestions may be criticised and sifted, to the advantage both of the Army and of the State.

When we take a comprehensive view of the present crisis, we cannot but look upon it as a warning sent in the time of peace, so that we may deliberate and wisely determine how to be better prepared in war, with an efficient Army in the field and with a reserve of trained soldiers irrespective of the Militia. As a help to this end, I shall first go into those influences which, in my opinion, bear injuriously upon recruiting: viz., inadequacy of pay and pensions, our Good Conduct code, the abolition of bounties, and the operation of the Limited Service (or Ten Years') Act. I will then submit that which I consider the best mode of recruiting. I shall, of course, have to refer frequently to the recommendations of the Recruiting Commission, shortly to be laid before Parliament.

First then, I shall speak of those influences which have undermined the present recruiting fabric, and will, I feel confident, unless removed, do still further harm.

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Pay.

I was induced to collect much of the information contained in this Lecture from reading a statement made in debate on the Army Estimates of 1865, viz.: "that, through the fixed price paid for his rations, the soldier had now more pay by one penny a-day than he had formerly." This statement—a thoroughly erroneous one, except so far as applied to a short period after the Irish famine—was unfortunately allowed to pass unchallenged by the then Secretary of State for War, and so went forth to the world, only to leave a false impression on the public mind. I proceed to refute it:—nay, more, to prove that the soldier has even less pay than formerly.

Out of the Infantry soldier's pay of 1*s.* 1*d.* a-day, his compulsory payments for bread, meat, vegetables, coffee, sugar, keeping up his kit, washing, barrack damages, sheet washing, blacking, soap, &c., average about	9¾*d.*
The following payments are not compulsory, but the little luxuries they provide are within the reach of every hale and hearty young labourer: viz., tobacco; and butter, or cheese, or a herring, for breakfast and supper	2¼*d.*
There will thus remain to the soldier, for pocket-money or for beer	¾*d.*
Total.....	1*s.* 1*d.*

Were we to examine, at this moment, the ledgers of any Infantry regiment in the service, we should find scores of instances where for one month, and probably, in some cases, two, or even three months together, men have only received 1*d.* a-day; so that if that penny were spent in tobacco—and I have known a man to give away his dinner for tobacco—they could only have had dry bread for breakfast and supper all that time. There are hundreds of men in the Army who will only receive 1*d.* a-day all this present month.

And here I would mention—to show how statements are made at random—that an Officer writing on recruiting, in the December number of *Macmillan's Magazine*, asserts that the soldier has substantial rations, consisting of three meals a-day, and is left with a balance in his favour of about 4*d.* a-day; the fact being, that two of the three meals consist, as I have shown, of dry bread and coffee, while the third stands condemned by the Commissioners as insufficient; and the "balance," when scrutinized, turns out to be the imposing sum of three farthings!

The following calculations were made from the Army Estimates of 1844 and 1865, and other reliable sources, to show what really has been done for the soldier in the last twenty-one years, the period of a soldier's service.

It would not be convenient to go more deeply into figures just now.

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In 1844 the soldier paid for his ration of bread and meat 3½*d.*	Now he pays 4½*d.*, or £1 16*s.* 9*d.* a year more.
Then he paid ¼*d.* for his pound and half of potatoes.	Now he pays ¾*d.*, or 15*s.* a year more.
Then he paid ½*d.* each for his two oz. of butter for breakfast and supper.	Now he pays 1*d.* each, or £1 10*s.* a year more.

After deducting from the total of these sums (£4 1*s.* 9*d.*) his gain, through the reduced price of groceries, of 13*s.*, we find his actual loss to be £3 8*s.* 9*d.*

Multiply this by 79,000 (the number of men serving in the United Kingdom), and we find that the Army is paying more for the common necessaries of life than it did twenty-one years ago by £271,562. Add to this the £6 a-year each to be deducted for the 15,000 men on the reduced pension, together with their loss through the difference in the value of money, and we find the Army a loser to the extent of £361,562 a-year.

Now how do the Commissioners propose making up this loss, in part, to the soldier? Not by a direct increase of pay, but by supplying him with articles in kind. This, at first sight, may appear quite an immaterial distinction; yet it is a point of vital importance, and the proposed plan would act, I think, most unjustly. It would still leave the Army, as a body, open to the taunting question of the civilian, "Who would work for 1*s.* a day?" It would be unjust to the country, as this 1*s.* a day does more harm to recruiting, than showers of circulars, distributed through magistrates and parish ministers, will ever remove. It would be unfair to the poor married soldier, as he cannot possibly afford to consume 1 lb. of meat in his family daily. It would be unjust to the economical, steady soldier, as it would deny him the privilege of putting money in the Savings' Bank, by being careful of his clothing. (And, having mentioned clothing, I would remind you that, though it is well known that many men wear out their clothing half as fast again as others, we still cling to the periodical issue of clothing. Many officers, I know, approve of it from the laudable desire to see their men look smart; but it must be in the experience of many to have witnessed a particular regiment in garrison, or troop or company in a regiment, where the men have been more discontented than those around them—the cause frequently being that all men alike are compulsorily supplied with an expensive article of clothing whether they require it or not).

I have proved that the soldier is paying more for his subsistence, by nearly 2½*d.* a day, than he did twenty-one years ago. Pay him back this, and his pay would be 1*s.* 3½*d.* a day; the shoes and half trousers given him gratis since 1844, together with jacket, half cap, and the additional ¼ lb. of meat recommended by the Commissioners, represent a money value of 2½*d.* a day more—in all 1*s.* 6*d.* a day. Out of this 1*s.* 6*d.* let the soldier be charged 6*d.* a day for his ration, and also for every article of his extra clothing, the same as for his necessaries; this would encourage thoughtfulness and economy, and would be a

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source of satisfaction and contentment. It would cost England no more, and would save her in appearance from driving so hard a bargain with her troops. For any sum less than 1*s.* 6*d.* a day it is hopeless to think of keeping our ranks complete.

Our Good-Conduct Code.

Our Good-Conduct Regulations, again, exercise a prejudicial influence on our recruiting. Those Regulations are, I think, in too many instances, open to the charge of being weak in conception, faulty in principle, and capricious in their working.

They are weak in conception, as they were designed to restrain the drunkard and absentee, the very men who would rejoice in extra pay could they get it; but who, practically, never try, and never hope to get it. Such men are kept in order by the power vested in the Commanding Officer, without any other aid whatever. The moderately good soldier, for whom the Regulations were not originally intended, and who did not require them, is the only one whom they benefit. They make the paymasters' accounts more intricate, give triple work in the orderly-room, and convert Captains and Commanding Officers into common clerks by obliging them personally to record the most trifling punishments.

They are faulty in principle. The man who aided in suppressing the Indian mutiny, perhaps fought seven or eight battles, wears the medal for distinguished conduct in the field, whom his captain knows to be a thoroughly good and brave though thoughtless soldier, sees his medal robbed of all its charm when, it may be, an incorrigible young scamp of three years' service is getting extra pay because he has just contrived to keep out of the regimental defaulters' book. A man may be thoroughly bad, yet get extra pay, and wear distinguishing marks for good conduct, nay, get extra pension, and a good character on discharge.

They are capricious in their working. Many men with three or four distinguishing marks for good conduct have returned from India, after suppressing the mutiny, to complete their service of two or three years, in the full hope of enjoying for life the benefits which these badges are said to convey, and which these same Regulations proclaim that every faithful soldier deserves. Yet from change of scene or circumstances, or from some other cause, they have committed themselves and lost their badges. They have thus paid in forfeited pension a fine of not less than £30 for each offence, their former nineteen or twenty years of exemplary conduct availing them nothing; and this in addition to undergoing the punishment necessary to enforce discipline. I have heard of men losing all four badges in the last year of their service, thus forfeiting £120. Will such men aid in the recruiting of our Army?

I would respectfully and earnestly ask the Officers of the Army, as a body, to consider the effect of protracted uncertainty upon the minds

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and tempers of their men; the wrong inflicted upon the loyal heart, rough-hewn though that heart be; the effect of ignoring the noblest virtue that can animate a soldier's breast, true courage. by placing Routine in the front rank, chivalric dash and manly hardihood in the rear.

I witnessed the establishment of the Good Conduct Code, and for many years assisted in the orderly-room to carry out its provisions, and my opinion of it has never once changed.

I would here suggest—

That the soldier should have but one distinguishing mark: his medal for being in action.

That payment, as an indirect bribe to keep out of the defaulters' book, be at once abolished. Good behaviour is part of a soldier's duty; besides, the power vested in the Commanding Officer is sufficient to restrain the worst men in a regiment without the aid of such machinery.

That, instead, extra pay for length of service be granted: 1*d.* a day after seven, and 2*d.* after fourteen years' service.

That no man be deprived of his extra pay unless he be disrated and passed to the second class.

That no man in the second class receive extra pay.

That time in the second class shall not count for extra pay, but previous service shall not be forfeited by being in the second class.

The advantages of this system would be that the soldier would be more contented while serving, knowing his extra pay to be a certainty.

Abolition of Bounties.

The advanced education of the day is, indirectly, another link in the drag-chain of our recruiting. The annual payment of wages in this country is over £300,000,000. It is now known, even by the fighting class, that the old household word "A veteran's shilling a day pension" is but a snare; and this knowledge keeps the thinking men from joining. The serjeant has not even bounty to offer. Yet bounty is but the earnest in the bargaining for life and limb, and a custom so old, so universal, and such a necessity in this profession of war, that I wonder how any one, even though regretting the system, could propose to abolish it. The Commissioners themselves, while opposed to the system, recommend bounties to induce men to re-engage in India. It may be argued that bounties are detrimental to discipline. Granted; but is not the tenderly-handled "Ten Years' Act," with its increased number of young soldiers and its striplings in stripes, still more so? Where 100 experienced non-commissioned officers left the Army in 1858, about 500 left in 1865. Will their successors, with much less experience, know so well *how* to command men; to study their varied tempers and dispositions; watch over, guide, restrain, and bear with follies and failings? Will they command the same respect, and be such stays to discipline?

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The "Ten Years' Act."

The Limited Service (or Ten Years') Act is another, and perhaps the immediate, cause of our being so short-handed. For however thoughtless and reckless a man may be when he enlists, his spirit will inevitably be toned down by ten years of discipline; at the same time he will have learnt to set a higher value on his capabilities. Is he likely to re-engage for 1*s.* a-day, and only one-half the pension given to his comrade in 1854, when he can leave and share in the £300,000,000 paid for wages? No; so looking upon himself as an injured man, he turns his back upon the Service, resolved to persuade every young fellow in his neighbourhood to shun the Army, where, he says, there is not a fair wage for a fair day's work.

The injurious influence which these discontented men exercise on the recruiting can scarcely be estimated; and it is increasing daily, as they take their discharge. What else can we expect when England, not disdaining to take advantage of their thoughtless improvidence, their poverty, their ignorance, and the adventurous spirit which prompts them to break away from the dead level of a village life, dictates to them such terms as these:—"Our agreement shall be that you give "me the best ten years of your life; that you be ready at all times, "with your life in your hand, to do battle with my enemies, to guard "my honour, and extend my trade; that all that time you shall "follow no other occupation, or do anything to provide for a rainy "day, to lay by anything for the time when your constitution is "impaired, or the infirmities of age creep on you. In return for all "this, I engage to feed and house you, but should you be cut off by "battle, by shipwreck, or by disease, neither wife, nor child, nor "mother shall have any claim upon me. Should you survive these "dangers, I will keep you on the tenter-hooks of suspense, by not "promising to take you on again. I may, or may not, give you at "parting a good character; but in any case I shall send you back to "your native village in regimentals, with 5*s.* in your pocket to provide "food and lodging until you can get work: for clothes, you may find "them as you can."

Now this is literally England's present agreement with the soldier; surely it is not to be the agreement of the future?

To remedy so great an anomaly, there must be a compromise: the country must make the advance. Can we call it an advance to add, as proposed, two years to the soldier's first period of service? To show the havoc made with the constitution, even with the present term: in the three years ending 1865, we had 42,457 recruits finally approved, while in the same period we lost by death, or invaliding, 24,971—more than 50 per cent.

I would suggest:—

1. *That the Ten Years' Act be repealed; and that in future all men be enlisted for twenty-one years; but—*

2. *That any man may claim his discharge at the end of fourteen years; it being at the same time imperative that he join an Army of Reserve, in*

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which he shall serve fourteen years more; then to be finally released with a pension of a shilling a day. It should be borne in mind that, owing to the difference in the value of money, 9*d.* a day twenty or thirty years ago was a better pension than 1*s.* is now.

3. *That soldiers who serve twenty-one years in the Active Army be finally discharged with* 1*s. a day pension.*

The soldier's pension is but a lottery at best, as there are five chances to one against his living and serving twenty-one years, so as to get even the minimum rate. Before he can obtain the maximum rate, he must comply with the condition of keeping out of the defaulters' book. How much better to name a sum, though a less one, which every recruit's mind could grasp, and every soldier look upon as a certainty.

To confirm my statement that there are five chances to one against the soldier living and serving so as to be entitled to length of service pension, I would state that out of all the men who enlisted in the years 1842, 1843, 1844, only 2,000 were discharged in 1863, 1864, and 1865 respectively, after having completed their full service of twenty-one years. It would be an instructive return that would show how many of these 2,000 men annually receive the maximum rate, and how many of the recipients were Officers' servants, working men, bandsmen, and others, who have greater liberty, and are not so closely looked after. My own conviction is, that nine-tenths of them are of that class, and only one-tenth of the hard-working duty soldiers. Surely there need not be so much cavilling about the *rate* of pension when so few get the pension at all.

4. *That men be allowed to purchase their discharge freely, at such a price as shall pay back their enlisting and other expenses; and, if at home, to find a substitute.*

By this system the soldier would have the option, which he has not at present, of taking on again; and the services of every man, in one shape or another, would be secured for twenty-one years. We should, moreover, save the expense of bringing men home for discharge.

While paying the soldier a very moderate pension for his fourteen years' service, we should ultimately get an Army of Reserve (which a fortnight's drill would at any time render efficient) without its costing one farthing; for the men need not even be clothed, the only necessary parade being their quarterly muster to receive their pensions—the Staff for their payment is already in existence. Finally, our discharged men would be examples to the youth of their villages of what the country does for the soldier, instead of, as now, being a standing warning against enlistment.

Pardon a short digression. It has often struck me that the cause of recruiting is not assisted by the disparaging tone in which some military men who contribute to the Magazines allow themselves to speak of the soldier. I am free to confess that the result of the system introduced by Charles II. and his immediate successors, jealous of the constitutional forces, of depending for support on foreign mercenaries, and the impressment into the ranks of the refuse of our jails, was that the character of the soldier fell to zero. The desperate nature of these men, and the terrible discipline necessary to keep

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them in order, caused every mother to look upon her son as lost when he enlisted.

All this, however, has long since been changed considerably for the better. Why not then appeal to the patriotism and encourage the pride that lurks beneath the pluck of our fighting class; why not rouse the martial spirit of our Army by dwelling on its matchless prowess, rather than speak of our soldiers as the off-scourings of our cities? Such language not only degrades the Army in the eyes of foreign nations; it lowers it in the opinion of the community, and thus damages the recruiting.

The favourite cry of our military Magazine writers is "a better class of men." Now who is it that is dissatisfied with the soldier? It cannot be the country, now upon her knees soliciting his services. Is it a Napier, who pays him such a noble tribute in his regrets?—"I should have won my promotion by being first in the breach, had not a man of my own company dashed in before me." Is it a M'Gregor or a Florence Nightingale, both of whom dwell in language so eloquent on his affection and devotion? In what particular, then, is the soldier deficient? The stamp of men we have is the only one we are ever likely to get, and well they fulfil the conditions of their hire. Gauge them as you will, measure them by any continental standard, and they are giants clothed with victory.

With the same gallant Officers to lead and guide, would the Indian strife have been more nobly sustained or sooner terminated; would the basis of Indian prosperity have been more permanently laid, or the sword have bound her to England with a stronger tie, had the 30,000 in the ranks who accomplished that mighty task been taken from the upper educated million instead of from the lower?

To my countrymen I would say: If you are not prepared to pay substitutes to fight for you, you must fight yourselves. Your not being able to get men to risk their lives for you for 1*s.* a day need cause no wonder. Why deny the soldier the right to participate with you in the general prosperity of the country? One-third of your surplus revenue would meet the difficulty. Try the very moderate sum of 1*s.* 6*d.* a day; if that sum does not answer, increase it. Only make the enlisting mart as attractive as that for labour, and men will flow into it like a river.

The Report, with all respect be it spoken, places the Commissioners in the position of a witness who tells the truth, but not the whole truth. They tell us of the gain to the soldier through the reduced price of his groceries; but they do not tell us that his loss is five times greater through the dearness of his other provisions.

To combat the strong opinion in favour of retaining the "ten years' men" which pervades the minds of the Officers of the Army, they give a return to show that, while the casualties from all causes in the five years ending 1865 were 93 per thousand, only 14 were limited service men. But they do not say that the Act would not be in full force for eleven years after the commencement of the return (*i.e.*, until 1870).

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But what does this return really prove with regard to the working of the Act? Absolutely nothing: while it tends to create an impression unduly favourable to it. For, on reference to another return in the Appendix to the Report, we find that exactly one-half of the time-expired men took their discharge in India; *this* is the return to prove the working of the Act, and it confirms the opinions entertained by the officers of the Army. To show how gradually, yet how surely, the evil of the Act is progressing, in 1863 there were 1,927; in 1864, 3,592; and in 1865, 6,088 men who declined to re-engage. This, doubtless, will go on increasing until the climax is reached in 1870.

They tell us that there is a deficiency in the number of recruits; but they do not tell us that the deficiency is probably 18,000. This, I think, I shall make clear from returns which I hold in my hand. In the three years ending 1865 there were 42,497 recruits finally approved, while the casualties from all causes, in the same period, numbered 61,474, thus leaving a deficiency of 17,977. Should the same deficiency have occurred in 1866 as in 1865 (and doubtless it is even greater), we are wanting at this moment 26,000 men, and in the present year it will be 34,000. From this we have to take the late nominal reduction, provided there was no deficiency in 1862.

Nor is this the worst part of it. This 34,000 would be full 50,000 (or one-fourth of the whole Army) had we not, since the Indian mutiny, continued a war tax upon our manhood in taking men one inch, and for a short time, two inches lower in height than we have done in peace, for the last century, except when raising reserve or 2nd battalions. So that in case of war, we have not now the men between 5ft. 5in. and 5ft. 6in. to fall back upon. Nearly one-half of our recruits are now under 5 ft. 6 in., hence such a number of boys.

PROPOSED SYSTEM.

The best system of recruiting is that which shall procure the greatest number of men at the least cost per head. The foundation of the system must be, as at present, the giving and receiving the earnest or enlisting-money, and the completion of the agreement before a civil magistrate, in taking the oath of allegiance. I beg to call your attention particularly to this last point, that enlistment is not purely a military transaction—it is on a civil foundation that the superstructure must be built.

The Commissioners, after deploring the failure of the present system to develope the military resources of the country, go on to enumerate the advantages which a military career presents, and to recommend further privileges—scarcely one of which, however, can be appreciated by the recruit, and which, taken together, will probably fail to induce any more men to re-engage.

They then say that the high rate of wages is undoubtedly the obstacle to recruiting, to be removed only by higher pay; but, notwithstanding, they would seek a remedy in patching up the present organization. They would multiply almost indefinitely the number of commissioned Officers, back them up with non-commissioned

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Officers and the Militia, and establish large depôts for the reception of recruits.

The appointment of the additional Officers would be a useless expense, the rather that their regiments would receive no benefit from their services; the depôts would be costly and almost useless, unless we had recruits in excess of the establishment.

As the Commissioners recommend having recourse to the assistance of the Militia, I shall here say a few words about that service in connection with recruiting.

For the information of the uninitiated, I may explain that for every man enlisted there is an allowance of 5*s*. to the subdivision Officer for clerking, postage, stationery, and other incidental expenses, and partly, perhaps, as a slight remuneration for extra duty.

As the Staff Officers of Pensioners and Adjutants of Militia act as Subdivision Officers, every recruit enlisted by their men reduces the allowance of some other Officer; for instance, I am myself an Adjutant of Militia, and were the recruits not enlisted by my serjeant, the recruiting party in the town would secure them, to the benefit of the district Adjutant. Some years ago the Militia did recruit, but long before the order was given to discontinue doing so, I had ceased to take any interest in the matter, from the want of that cordiality and support necessary to carry on my duties properly.

Nor do I think this will be wondered at when I relate the few following instances of the working of the present system, out of many that have come under my notice:—

Two of my own men enlisted for a regiment of the Line which had just completed its establishment; of this last fact I was not aware until I had reported their enlistment to the district and received for reply, "The men are not to be forwarded, as the corps is not open to recruiting." As the men's pay was running on, and I had no power to discharge them, I wrote for instructions, but was merely told there were no instructions to give. I was thus driven to commit the irregularity of writing direct to the Adjutant-General, who ordered the men to join their regiment.

Another man was rejected for being, as alleged, marked with the letter D, but having known him from a lad, I was convinced that he had never been in the Army, and on his return had him prosecuted before the civil court, where it was proved on oath that he was not marked and that he had never been in the service. I was obliged to take this step to recover the expenses.

Another man enlisted with the consent of the Commandant, but from the mistake of a clerk his printed "release" was wrongly dated; for this he was rejected at the district, although the writing of a letter would have set right the error, and although there is a general order saying that such an irregularity is of no importance provided the release is subsequently obtained. The Officer of Pensioners thinking the Inspecting Field Officer's decision final in such cases, never moved in the matter, and so lost the expenses, while the service lost a good soldier. This same Officer had a man rejected for being half an inch too tall: another man, on being rejected, went back home, was immediately picked up

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by a guardsman, and is now serving. One man, enlisted by a pensioner, was rejected at one district for being marked for desertion, went to another district, and there was passed.

As such rejections almost invariably throw the expenses on the sub-division Officer, it need not surprise any one should he avoid running these risks by objecting to pass men whom he may all the time deem perfectly eligible, thus possibly obliging the recruit to tramp it to the head-quarters of the district before he can get enlisted, or causing his loss to the service altogether. A few days ago there were shown to me the orders from two districts to recruiting parties, and if I recollect right, they were worded thus:—"All regiments open for recruiting, except those detailed in the margin." How easy is it to imagine a serjeant stationed, for example, in Dumfries, recommending the recruit to go, we will say, to the 60th Regiment, which is stationed at Limerick, simply because he happens to have lain with the regiment, there being all the time a corps at Glasgow, to which the recruit would as readily have gone. It is within my own knowledge that of two men enlisted in Dumfries, not very long ago, one was sent north to Glasgow, round by Edinburgh, in order to get to Canterbury; the other sent south to Carlisle and Liverpool, in order to get to Glasgow.

Can we, in the face of such facts as these, refuse credence to the statement recently made in a military periodical, that each man obtained for the Army must cost, from first to last, nearly £20 before he is finally approved?

The system I am now about to submit in detail would, I venture to think, remove the antagonism between the services. It is this:—

1. That the recruiting be a separate department at either the War Office or the Horse Guards, and under the immediate supervision of an Officer of rank, as in the case of the Militia.

2. That all recruiting districts be abolished, as being expensive, unnecessary, and detrimental to the service.

[They are but relics of the ante-railway period, when recruits were collected in large numbers to be marched through the country by conducting serjeants, and when it took more time to communicate with the district than it would now take to communicate with the Inspector-General of Recruiting in London.]

3. That, instead of having recruiting districts, the Staff Officers of Pensioners and Adjutants of Militia be the recruiting Officers, corresponding direct with the Inspector-General.

[This would obviate the necessity of covering the whole country with Officers of the Line, taken from their regimental duties; while the fact of the Officers of Pensioners and Adjutants of Militia having served in, or now belonging to, the Army, and their sympathies being still with it, would ensure the duty being efficiently done. It would also release for other duties six Field Officers, Paymasters, Surgeons, and Adjutants. It would moreover save much useless expense, and simplify the service. One illustration of this: a few months

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ago it was necessary to obtain a special authority to enlist a man at Dumfries. From the application having to go through the district, thirteen letters, including copies, had to be written. Had the application gone to the Inspector-General direct, the answer would probably have been received in two days, instead of a fortnight.]

4. That, as many men are lost to the service through living away in the country, all serjeants of Militia and all serjeant pensioners be allowed to enlist recruits; and that all other pensioners and all privates of Militia be allowed one-half of the enlisting money for bringing a recruit.

5. That, in London, where there are a number of parties, and duties for the paymaster irrespective of recruiting, there be a paymaster, surgeon, and adjutant as at present, to be under the immediate command of the Inspector-General.

6. That in our large cities and towns there be recruiting parties stationed as at present, at the discretion of the Inspector-General. These to be under the nearest recruiting officer, though he may be of a different service; a clause being inserted in the Mutiny Act to authorize it.

7. That any man be enlisted for his own country corps, if there be one, and he wishes it; if not, then for some corps near at hand, or as may be ordered from time to time, thus—Parties in Scotland to enlist for corps in Scotland; those in the inland portion of the north of England for corps at Preston; the midland counties for Weedon; those on the east coast for Chatham, as men can be sent even from Newcastle for 5*s*. each. The country would, of course, be divided into districts accordingly.

8. That all men be sent direct to their regiments.

[This would be an immense saving as compared with the present system, or the one proposed by the Commissioners.]

9. That all men be examined by a surgeon of the Line, if there be one, if not, the Militia surgeon to examine them before they leave their county; the examination in either case to be final.

10. That no recruit be rejected at his regiment, except by a medical board.

11. That should the head-quarters of a regiment of Militia be removed from its county, its place be supplied by parties from the Line at the discretion of the Inspector-General.

12. That the reward for enlisting be increased to £1.

13. That men be enlisted up to 30 years of age, except for the cavalry.

[This possibly may be objected to, as men of that age cannot generally be made so smart, and do not so readily take up their drill, as younger men. Still there are fourteen years' good service in a recruit of 30; constitutionally, too, he would be better able to battle with

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the Indian climate. All men enlisting at that age might be transferred to the Army of Reserve at the end of fourteen years, at the discretion of their commanding officer. By this means we should have hundreds of additional recruits.]

14. That when a recruit offers himself through a bringer, it shall be lawful to enlist and attest him at once, if he wishes it; in other cases, forty-eight hours only to be allowed. The present "four days" favours desertion, and causes unnecessary trouble to the serjeant.

Such, I submit, would be the best mode of recruiting for the Army.

I cannot conclude without expressing my regret that the limited time at my disposal has not enabled me to allude, except incidentally, to that branch of the service with which I am at present connected—the Royal Militia—a force of which, after some years' experience, I have the highest opinion, an organization on which I feel we may entirely rely, and which I believe to be almost indefinitely capable of development. The system I have ventured to propose would give us an Army of Reserve independent of the Militia; but its services would, I think, be dearly purchased were it to be allowed to supersede, instead of supplementing, our old constitutional Army.

I would also say that if, in any of my remarks, I have let fall anything that may have sounded too strong—that may have been pitched in a key to which the ears of some of my audience are unaccustomed—I trust I may be pardoned. I have nothing extenuated; but I can conscientiously say that I have set down nothing in malice. If there is one subject more than another which, for its proper handling, requires us to look facts—even unwelcome facts—boldly in the face, I conceive it to be the subject of this Lecture:—the great and urgent question "How shall we recruit our Army?"

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Evening Meeting.

Monday, February 4th, 1867.

MAJOR-GENERAL THE HON. JAMES LINDSAY, in the Chair.

NAMES of MEMBERS who joined the Institution between January 21st and February 4th, 1867.

ANNUAL.

Commerell, John E., C.B., C.C., Capt., R.N. 1*l.*
Sharp, W. E., Lieut., R.A. 1*l.*
Strange, Tom Bland, Capt., R.A. 1*l.*
Boscawen, Hon. E. E. T., Lieut. Coldstream Guards.
Hughes, Waller Philip, Lieut. Coldstm. Guards.
Bruce, Harvey J. L., Lieut. Coldm. Gds.
Wood, A. R. M., Lieut. Coldstm. Gds.

A SHORT GUN, THROWING A HEAVY SHARP-EDGED DISCOIDALLY-FORMED PROJECTILE.

By Lieutenant-General W. N. HUTCHINSON.

IT is with much pleasure that I accede to the request of the Council to read a paper this evening respecting a gun which I patented in 1861. I will endeavour to be concise in my remarks; yet, as some visitors may be here who have not paid much attention to gunnery, I must, to make myself understood, risk the remark from those conversant with the matter, that I am at times repeating "a twice told tale," and explaining what requires no explanation; but it is due to myself to say I had the consideration to request that another subject, as well as the present, might be brought before you this evening. Yet the subject is one of importance, whether my project be right or wrong; for, notwithstanding the marvellous improvements effected within the last six years in our ordnance, and our being at this moment far ahead of every other country in effective artillery—unquestionably so at long ranges—it is certain that the nation is not fully satisfied—it does not feel confident that we have adopted the best method of rifling that can be devised. This is evinced by the changes frequently taking place, and by the fact that there are warm supporters of very different systems. The Americans have shown great inventive talent practically applied to useful purposes. We are indebted to them for useful lessons in ship-building, and for machinery in saving labour, both in domestic and agricultural pursuits. Ought we to feel positive that they are wrong in their avowed partialities for projectiles of vast weight? Not long ago they were much in

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advance of us. They had a powerful serviceable gun for slow firing (the rifled Parrott), at a time when we had no gun of greater weight to oppose to it than the good old 68-pr.

They have recently evinced an unexampled capacity for war on a grand scale, and the ordnance we have seen on board the "Miantonomoh" prove that, regardless of expense, they act up to their professions, and unhesitatingly adopting the principles of gunnery advocated by their ablest artillerists, submit to the inconvenience in small turrets of guns of 20 tons and great recoil, discharging shot of 480 lbs. We read, too, of their having cast guns that will throw shot twice that weight. It is true we have heard of many of their guns bursting from firing heavy shot too rapidly—but this is no proof that heavy shot are not required, it is rather a proof that such guns are required as will project heavy shot. The "United Service Gazette" of the 12th ultimo tells us that the Americans were testing the endurance of a rifled 12-inch Rodman of 26 tons, by endeavouring to fire 1,000 rounds from it—shot 600 lbs. weight, powder 55 lbs. By the last report it had been fired 400 times, and continued as sound as ever.

The success of the Peruvians at Callao against the Spanish fleet was due, it is said, to a few 480-prs. We are told that Rhenish Prussia is sending to the Paris Exhibition a piece of ordnance of 17½-tons, that will discharge a cast steel cylindrical projectile of 1,100 lbs., using 60 lbs. of powder. Last summer an Italian iron-clad left for the Adriatic, carrying 600-prs. Indeed the defence from iron-plating so improves from day to day, that all scientific warlike nations are alive to the advantage, I might say necessity, of having heavy shot of some form or other that can be projected with good initial velocity, and maintain it longer than a sphere. How to obtain it is the question. The grand requisite at close quarters, which British sailors have always loved, is good initial velocity against iron-clads; yet no rifled guns have hitherto been constructed that will stand a charge of powder adequate to the double duty of forcing a ponderous projectile through the spiral grooving, and give it such velocity. Hence our artillerists have, as a rule, confined their attention to comparatively light projectiles, and have endeavoured to make up by velocity for deficiency in weight, and wonderful has been their success as regards *terminal* velocity and precision. We have seen it stated that vast sums have been *wasted* in attaining this perfection, yet no money can be better spent than in making judicious experiments to obtain the best arm for both our Navy and Army. It is to fight the guns that the expenses are incurred of ships, dockyards, sailors with their officers, &c., and those who have not thought upon the subject have little idea how small a percentage of the cost of the Navy is assignable to the guns, yet everything ultimately hinges upon their efficiency. It is ill-judged, false economy to be sparing of money for good arms. In 1859 I urged upon Government the advantage of providing our troops with breech-loaders, and a barrel that would discharge, when required, a hardened bullet to pierce a gabion or a mantlet. Contracts had just been entered into for large supplies of Enfields, therefore on economical grounds, if for no other, my proposition could not be entertained.

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The country would have cried out, "What unnecessary expenditure!" and happily it has proved unnecessary; but it might have been fearfully otherwise.

It has been calculated that every effective bayonet on parade costs us fully £100 a-year. Bounties, pay, pensions, rations, clothing, barracks, hospitals, transport by sea and land, and other expenses,—cost of regimental officers, staff, commissariat, Horse Guards, War Office, *all* are solely incurred to bring bayonets into the field at the right moment; therefore it is reasonable to believe that every bayonet really costs £100 a-year, yet we begrudge a few extra pounds in the price of the barrel on which the bayonet is to be fixed. Verily John Bull is an inconsistent old gentleman! A barrel will last more than seven years; but say seven years. The difference between the price of the best self-priming breech-loader (obtained in large quantities) and an Enfield, would be less than £7; but say £7, which being an expense incurred for seven years, would be at the rate of an additional £1 a year. That is, the cost of a soldier superbly armed would be £101 a year; of a soldier indifferently armed £100 a year. In other words, 100 men armed indifferently would cost £10,000 a year; 99 men armed superbly, £1 less, viz., £9,999.* Comment on this fact must obviously be unnecessary, for there can be no doubt, other matters being alike, that the 100 men would have no chance whatever against the 99. If the country will only allow a certain fixed sum for the maintenance of its army, would it not be good policy to take 1 per cent. off its numerical strength rather than not make it as efficient as possible. But the calculations are on an extravagant scale. The extra expense of the better arm would be nearer ten shillings annually than a pound.

The admirable plan sanctioned for the conversion of the Enfield into a breech-loader, and the excellent ammunition devised for it, gives us good breathing time. Availing themselves of it, Government have advertised, offering a prize for the arm considered by an impartial committee the best suited to a soldier's requirements. Before long this step will doubtless put a first-rate weapon into his hands, for it is not so much the pecuniary value of the prize that will excite emulation among our leading firms, as the distinction of being the successful competitor, and manifestly they will find much opening for improvement. Rifled ordnance, however, has reached such perfection that it is difficult to imagine how it can be much further improved. But is rifling the best system that can be adopted for giving rotation to a heavy projectile; and is the cylindrical the best form for that projectile?

The three desiderata sought for in artillery are—

1st. Maximum weight of projectile.

2nd. Length and accuracy of range.

3rd. Facility in loading.

To attain the first, the size of guns has been increased, till their weight renders them almost unmanageable.

* 100 men × £100 = £10,000
99 men × £101 = £9,999.

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To attain the second, conical shot have been introduced, and barrels rifled to secure rotation. The conical shot, notwithstanding its inferior initial velocity, is a great improvement upon the spherical for light shot, yet it seems not the shape best adapted for traversing an elastic resisting medium; and when fired at an elevation, the resistance and displacement of air are increased by the axis of the shot soon deviating from the line of flight, the shot as it were travelling sideways. The longer the projectile the greater the evil, and when it *does* penetrate through the object aimed at, it makes but a small circular aperture. The rifling weakens the barrel at the same time that it increases the strain on it, and causes friction, and consequently wear. Nor has any altogether satisfactory method yet been discovered of reducing this wear by coating the projectile with soft metal. Much of the force of the expelling gas is spent in driving the projectile through the rifling that ought to be exerted in driving it forward and giving it good initial velocity. The greater the rotation (required for stability in flight), the greater must be the spirality of the rifling, and the greater therefore the *vis inertiæ* to be overcome in giving such angular velocity to a longitudinally-lying bolt, often greater in diameter than the bore through which it is forced; occasioning in large guns a recoil that presents immense difficulties.

No country has as yet produced rifled guns that will with impunity bear sufficient powder to start heavy projectiles with great velocity, yet the friction is so severe, and the hot gas is retained so long in the bore, that although little powder is used, the barrel soon heats with rapid firing. Those who have had an opportunity of witnessing it say that the wear and tear is frightful.

The weight of a cylindrical shot is often increased by adding to its length, but in this case the gas acts upon no increased surface, the transverse area being the same whether the shot be long or short. To this is greatly attributable the peculiarly low initial velocity of long cylindrical projectiles. On the other hand, when the weight of the projectile is increased by giving it increased thickness (firing therefore from a larger bore), the flat surface at the rear causes a greatly increased vacuum during its flight.

The rotation round the longitudinal axis of all conical shot has this great disadvantage, that the instant the shot strikes any object not in a plane at right angles to the trajectory, the shot has a tendency to fly off rather than penetrate. It is owing to this rotation that effective ricochet firing along the line of a parapet has become impossible.

Elongated rifle projectiles, while sufficient rotation lasts, move throughout their flight in positions parallel to the direction in which they were first fired, hence they cannot strike the ground with their point foremost, except accidentally, after rotation has ceased, when they tumble over and become erratic in their movements. Such projectiles are consequently not suitable for vertical firing. Yet many naval as well as military men are of opinion that the more defensive-plating becomes a successful protection, the more will vertical firing be required.

These evils and deficiencies in large conical shot have much led to the

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tendency we have lately seen to revert to spherical, and to build smooth-bores of cyclopæan dimensions. They give a good initial velocity, but it cannot be long maintained, owing to the large surface the sphere presents to the resistance of the air.

To attain the third desideratum, viz., "facility in loading," various systems of breech-loading have been invented, but every system hitherto introduced has caused such weakness, increased weight and expense, and been attended with such uncertainty, risk, and liability to injury, that *all* are fast getting out of fashion.

To sum up the inconvenience of modern rifled artillery guns, which peculiarly affect heavy ordnance:—

1. They have much recoil.
2. They cannot throw projectiles of really great weight.
3. They have little initial velocity.
4. They will not stand large charges of powder.
5. They cannot, when large, be readily loaded except at the breech.
6. They are not handy. They soon heat with rapid firing.
7. The propelling gas presses against but a small part of the long cylindrical projectile.
8. The heavier the projectile, unless made disproportionately long, the greater the vacuum in its rear.
9. They have, as a rule, little penetration when striking an object obliquely.
10. They make but a small aperture.
11. They will not, as a rule, enter; and none will cut a way through water.
12. They cannot be used effectively for enfilading ricochet firing.
13. They cannot be used for vertical firing.
14. They cannot, as a rule, throw red-hot shot, or shells carrying molten iron.
15. They are expensive.
16. They are not durable.

Doubtless immense talent and ingenuity have been exerted in manufacturing ordnance of a size, range, and precision that our forefathers would have regarded as fabulous, but is it certain that all this talent has been exerted in a right direction?

Mr. R. W. Woollcombe says (in a letter to the "United Service Gazette" of the 17th of last November), that as far back as 1854, he brought the subject of discs, and disc-guns to the notice of the Ordnance Select Committee.

In a valuable paper he read before the Royal Society in March, 1862, "On eccentric oblate bodies and discs as projectiles," he stated, that in 1859, with discs of nearly 8 ounces (virtually central sections of spheres) fired with 2 ounces of powder—the centre of gravity being placed above the geometrical centre—he obtained "a range "that, if not due to vertical deviation, must have been due to a velocity "of more than 2,000 feet per second."

At the following meeting of the British Association he read a paper on "oblate projectiles with cycloidal rotation, contrasted with cylindro-

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"ogival projectiles having helical, or rifle rotation." He explained therein that with a four-sided gun, not eleven calibres long, made for his discs, powder about 3-5ths disc's weight, he had obtained, at an oak target, 25 yards off, with an initial velocity of 1,487 feet per second (measured by Navez's electro-ballistic apparatus), a penetration double that of a spherical shot fired with proportionate charges; and that the initial velocity of the disc, compared with that of the spherical shot, was nearly as 15 to 11. Copies of these papers which were printed, and the gun and discs, are in this house. He generally made his disc to rotate eccentrically by cutting out a small circular piece off both sides, near the zone. Surely it will be allowed that he deserves great credit for having been the first to point out how the eccentric rotation long known to exist in nearly 99 out of every 100 spherical shot, could be turned to a profitable account by substituting eccentric discs for spheres, and by that change obtaining less windage, consequently a greater initial velocity, and from the oblate form a far better sustained velocity.

If half the genius and thought which have been expended since 1854 in the improvement of rifled guns, had been exerted in following up the very original idea first promulgated by Mr. Woollcombe, viz., that discs having eccentric rotation given to them would form better projectiles than cylindrical shot, it is probable that the country might have been saved millions of money, and now feel more satisfied that it possesses the best arm that could be used with powder or gun-cotton. I say, powder or gun-cotton, for mechanical and chemical sciences are making such vast strides, that he must be a bold man who will assert that years hence we may not have an entirely different description of offensive weapon.

The great penetrating power of Mr. Woollcombe's disc-gun seems to have been fully admitted,—but guns were already too heavy, and there was the drawback to its acknowledged advantages that the disc, being of much less weight than a sphere of some major diameter, was necessarily very light compared with the weight of the gun—and that the rotation was eccentric—a movement which, by displacing more air, was less calculated than when centrical to retain rapid rotation.

It appeared to me that these objections could be removed by firing the disc from the outside of a short chamber, which would allow of the disc being made of almost any weight, and of having centrical rotation. It would too, admit of its being cast in a yet better form for rapid flight, viz., with a sharp edge to cleave a path through the air, and leave but little vacuum in its rear. The sharp-edged disc is nowhere spoken of in Mr. Woollcombe's papers, but I have recently become aware that it is one of several modifications of discs described in his patent. A barrel of sufficient strength bored to that shape would obviously be so disproportionately heavy, that I had not previously imagined he had named such a form, and accidentally looking the other day at dates, I observed that in March, 1861, two months before the date of his patent, Messrs. Norris and Son (near Finsbury-circus) printed for me a pamphlet I drew up for private circulation, explaining with the

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help of a wood engraving, how a heavy sharp-edged disc conveniently fired from the mouth of a shortened gun. This which was read at the time by many, proves that the emplc such a shaped disc can be no infringement upon Mr. Woc patent, and it is certain that I am not interfering with it respects, for the principles of construction we propose wid He fires his disc from within a barrel, I mine from withc gives eccentric, I centrical rotation.

Though the gun I designed was singularly short I felt pr fident a good direction could be given to the disc, but ther undeniable objection to my project that the gas generated in a gun could act upon the disc for only a short time. I however, that this disadvantage could be compensated for b the gas press against a large surface of the disc—by giving the most unrestrained freedom in quitting the gun—by hav recoil, yet a large charge ignited in several parts simultane by using gun-cotton. On the assumption that a light gun cou manner be made to throw a heavy projectile with accuracy good initial as well as sustained velocity, I took out a patent f since renewed, which I believe on trial would be found—

1. To have little recoil.
2. To be capable of throwing projectiles of immense weigl
3. To have much initial as well as sustained velocity.
4. To stand large charges of powder.
5. To load, however large, with the ease of a breech-loade
6. To be handy. Not to heat quickly with rapid firing.
7. To present a large surface for the gas to act on.
8. To have the vacuum in rear of projectile but little incr adding to its weight.
9. To have good penetration when striking obliquely.
10. To make a large aperture when it penetrates.
11. To throw a shot which will cut its way through water.
12. To be admirably adapted for enfilading ricochet firing.
13. To be particularly well suited for vertical firing.
14. To be capable of throwing red-hot shot, and shells molten iron.
15. To be inexpensive.
16. To be durable.

Construction.

The projectile is formed of two equal frusta of equal and cones (cut perpendicular to the axis) united at their bases. In language, it may be called a sharp-edged disc. The following approximate proportions :—

Height of each cone about one-third diameter of base.

Height of each frustum about one-half the height of cone.

Less height to each cone would give a sharper entrance to in its passage through the air ; but this would inconveniently l

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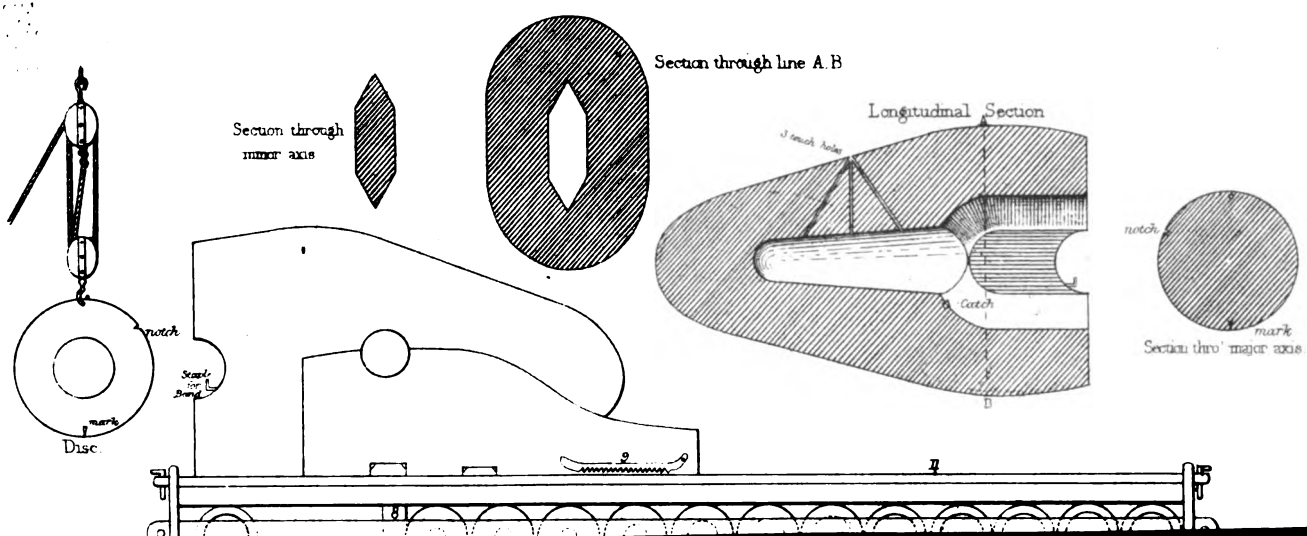

5. Metal catch working on pivot p fixed to under part of carriage.
6. Two projections on each side forcing catch into position to grasp 4 on rebound.
7. Narrow projection lying in a plane between projections 6 forcing catch to free itself from 4 after the first shock of the rebound.
8. Iron projection from carriage to press on rings when gun recoils.
9. Ratchet to lock on [illegible]

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its major axis, thereby increasing the swell at the muzzle of the gun, and presenting an unnecessarily large surface for a side wind to act on.

Less height to each frustum would displace less air, but it would diminish desirable weight.

The major diameter is nearly thrice the length of the minor.

Nature seems to point out this as the best form that can be adopted. A schoolboy would gladly select a similarly shaped stone to hurl from his sling, or throw with a spin from his fore-finger, being almost intuitively sure that the spin would assist him greatly. We must all feel that a penny piece thus thrown would go much further than the same weight of copper cast in a spherical shape; and that the penny would fly through the air yet quicker were it filed at the circumference to a sharp edge. Surely in gunnery the best form for the projectile ought to be the first consideration; the next how to give it rotation without exacting much from the powder, or straining the gun; for without rotation there could be no stability, and therefore no precision or range.

When concussion rather than penetration is required, the sharp edge of the disc can be rounded off or flattened. The gun's form would thereby be the stronger, and the disc present less surface to a side wind; but Mr. Hodson, and more particularly Mr. Woollcombe, have shown the advantage of tapering large projectiles at the rear. This advantageous system of tapering is yet more fully carried out in the sharp-edged disc; and the great success that has attended Major Palliser's pointed shot is another argument in favour of the sharp edge given to the disc. It is chiefly from the Mitford bullet tapering towards the rear that its range is superior to the Enfield.

It has been calculated that a disc, an arc of 60°—the central section of a sphere—presents a somewhat smaller surface for a side wind to act on than does a cylindrical projectile of same weight 2½ diameters long. The sharp-edged disc presents a much larger surface to a side wind; how much larger manifestly depends upon how much of the sharp edge is rounded off.

The gun is more the shape of a lengthened mortar than an ordinary gun (Plate II). It swells greatly towards the muzzle vertically in an oblong form, that it may receive the disc. The interior of the muzzle conforms exactly to the shape of the disc.

The exterior form given to the gun at the muzzle is supposed to be determined by calculating the thickness of metal necessary to resist the strain on the lines of greatest strain, viz., on the major and minor axis. That on the major axis is a bursting strain, such as the metal of a cylindrical gun is exposed to on every diameter. That on the minor axis is composed of a bursting strain, of much less severity, and a bending strain, so to speak, such as causes a bar loaded in the centre to bend, and would, by compression of the inner laminæ and extension of the outer ones, tend to cause the flat sides of the bore to assume a curved shape. Through the extremes of the major and minor axis so obtained, an ellipse is drawn which describes the exterior form of the muzzle of the gun.

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I have in the plan and model, made the muzzle extremely short. Probably it would be better somewhat longer, for the extremity might be so thin (especially as the gas expands there) as to add not inconveniently to the weight of the gun, and the additional length would allow the gas to act for a longer period on the disc. Many years ago Mr. Ross, of Exeter, built fanciful guns, the muzzle part being of wood, yet it is said they stood work for some time. This argues in favour of a light muzzle, and the gun would still be so short that there could be no vibration to affect the shot's flight.

The barrel may be cylindrical as in an ordinary gun, or conical, or oval, and not longer than suffices to hold the powder and wadding. Bored oblong vertically instead of cylindrically, more gas would press instantaneously on the disc, but the barrel would be weakened.

The barrel, if cylindrical, is exactly of the same diameter as the minor axis of the disc, therefore that axis determines the width of the bore. Should it be 9 inches, the disc would weigh about 800 lbs., the gun about 8 tons ;* but this is only a rough approximation, much depending upon the quality of the metal used in forming the barrel, and whether common powder or gun-cotton be used.

In the experimental gun, a notch cut in the periphery of the disc, fitted on a small projection of steel fixed in the interior of the muzzle exactly where, when the axis of the gun lay horizontally, the vertical diameter of the disc came in contact with the gun. Much rapid centrical rotation was thus obtained without any friction whatever, but the projection ought to have been fixed further inwards. The disc at starting was driven with unnecessary force against the upper side, and consequently some power was wasted that might have been better employed in propulsion. Moreover, there was an unnecessary strain upon the projection, or "catch," as we may call it. This catch seems best formed by a bar of steel driven transversely through the enlarged muzzle. Clamps on the extremities of the bar on the exterior of the muzzle would aid in preventing the cheeks from expanding. There are several ways of giving centrical rotation to the disc, but the notch on catch seems the simplest and most effective.

As rapid ignition is required, several touch-holes, for the reception of friction-tubes, radiate from one central priming pan; or the charge might be fired in more places than one by a galvanic battery. Quick-burning powder ought to be used. Gun-cotton might be more suitable than common powder; and from the very interesting account of it given us in this theatre by Mr. Abel, it seems not improbable that it may some day be brought into general use.

Owing to accurate fitting, the inner sides of the muzzle and the top and bottom surfaces give a good direction. *All* depends upon workmanship. If the disc fits without the possibility of wabbling, it must always start in the same direction as regards the axis of the gun. The least bend near the muzzle of an Enfield, Armstrong, or Whitworth will always cause a corresponding divergence in the shot on its leaving

* A manageable gun could be made that would project a disc of far greater weight than 2,000 lbs.—W. N. H.

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the barrel, and this divergence will invariably be a constant quantity. Under similar circumstances, it will be similar in every round. If the gun be well sighted, as far as can be judged from the trial made, there will be but little excuse for a bad score. The nearer the line of aim to the axis of the bore, the less is precision affected by any deviation of the axis of the trunnions from a horizontal position, therefore the sights, when it is practicable, will be placed on the side of the gun instead of above it. You will presently find that the Officer commanding the gunnery ship at Devonport has certified that he could not see why great accuracy should not be obtained as long as rotation could be preserved; and I think I shall be able to satisfy you that rotation will last as long as the disc travels. While it is rotating within the muzzle it should be in contact with the top and bottom and the two vertical sides, which all four govern the direction. The four sloping sides forming the two acute angles splay a little, about an inch from the extremity of the muzzle, in order that the disc, when escaping from the muzzle, may not touch those four sides. At one and the same instant the disc ought to cease being in contact with the muzzle in any part. This explains why a circular piece is cut off the muzzle. In this recess bolts are fixed for retaining the band (or stay) which will be described presently.

In order to prevent eccentricity laterally, which would cause lateral deviation in the flight of the disc, the mould in which it is cast should stand, as Mr. Woollcombe mentions, in a vertical position. One frustum —one-half of the disc should not be heavier than the other. The less distant is the centre of gravity from the central plane through the larger axes, the less is the divergence. Manifestly this distance will generally be less in the disc than in the sphere, as the major axis of the disc and diameter of the sphere being supposed equal, half the minor axis of the disc must be less than the radius of the sphere, therefore the divergence caused by unequal casting or the metal not being homogeneous, will, as a general rule, be less in the disc than in the sphere.

As it can rarely happen that the centre of gravity will be coincident with the geometrical centre, though it will usually lie in the same equatorial plane, the notch in the disc should be so cut that the centre of gravity shall be immediately above the geometrical centre. It was in this position only that Mr. Woollcombe felt certain of obtaining rotation with his eccentric discs, and evidently the rotation given by the notch locking on the catch ought always to be in harmony with the rotation that would be caused by eccentricity, were not centrical rotation caused by the catch. Whether, however, the rotation obtained by Mr. Woollcombe was similar to that of a progressing or a retrograding carriage wheel, he was not positive. The injury the experimental gun so soon sustained, prevented my easily ascertaining to a certainty which of the two rotations gave most initial and terminal velocity; for I had only to turn the gun over, thus bringing the lower part uppermost, to reverse the rotation.

In the specification of the patent for this gun, a description is given of a simply constructed machine for readily showing in what part of the disc the centre of gravity lies.

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The distance from the catch (in the muzzle) to the extremity of the muzzle is set off on the periphery of the disc from the notch. A mark is made there. Large discs would be slung into position by a pulley hooked* through a hole nearly in the extremity of the diameter running from the mark. The hole is exactly so cut that in loading, when the tackle comes in contact with the upper part of the muzzle, this mark almost unavoidably meets the extremity of the muzzle before the disc is rolled into position by depressing the breech, the notch locking upon the catch, or the disc is slung in a nearly semicircular cradle, which could be readily attached to the stay-bolts, and by an easily-devised contrivance, tilt the disc into the muzzle.

When the gun is depressed the disc is held in position by a band or stay of some kind passing round its front. It is made weakest in the centre, that it may break in that part on the gun being fired. When much elevated, no band can be necessary. Should it be found, notwithstanding the adoption of more than one friction-tube, that all the gas is not evolved before the exit of the disc, the disc could (if deemed desirable) be retained in the barrel for any required time, for the band could be made of any computed strength.

Clearly all the gas would be evolved were gun-cotton used; and the able manner in which this important subject has been treated in this theatre has greatly interested us, and induced many of us to believe that the investigations of the present Government Committee will lead to the material being more generally adopted. The designed gun from the shortness of its barrel, and the easy escape of its shot is particularly well fitted to stand the shock of exploding undiluted gun-cotton. It has been calculated that to impart the same propelling power as common powder, less than one-third of its weight would be required in gun-cotton; and as instantaneous ignition is wanted, its bulk would not be much augmented by the intermixture of raw cotton as introduced by Messrs. Prentice, therefore the charge to produce results equal to the action of common powder would occupy, say half its space. It follows, that short as is the barrel (or chamber) represented in the plan, it would become much shorter were the barrel expressly intended to hold gun-cotton.†

Moreover, which is of vital importance, the space which the cotton should occupy would never be injuriously infringed upon. The carefully adjusted fibres of the explosive material would be as little liable to derangement as if lodged in the recess of a breech-loader, for the charge would be inserted by hand, and the upper and lower part of the entrance of the chamber would be slightly enlarged, to retain in position and prevent the further admission of a closely-fitting wad, made somewhat deeper than the cartridge.

I named certain advantages that, for heavy projectiles, I thought this disc-gun would on trial be found to possess.

* The hook with two steel clamps, which are as readily attached as quickly removed.—W. N. H.

† A wooden model of a gun-cotton 32-pr. has since been forwarded to the Institution.—W. N. H.

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1. *To have little Recoil.*

Though the proportion that the weight of the gun bears to the weight of the disc is comparatively so small, there is but little recoil. Before the general adoption of breech-loaders, every sportsman practically knew that his double-barrel kicked, in other words, recoiled much when foul, from the rust or dirt retarding the passage of the shot; and that at long distances his birds were crippled, instead of being killed handsomely.

It is not rust or dirt, but rifling, that retards the cylindrical projectile and augments recoil. The sharp-edged disc stands on its edge in the *mouth* of the unrifled muzzle. Speaking theoretically, as the disc is in a vertical position, it is only in contact with the gun in *one* point, the bottom line of the muzzle becoming a tangent to the periphery of the disc all the time it is in the muzzle. A push from a child's hand would almost move a 2,000 lb. shot. Balanced on one point, it is ready unresistingly to roll through the muzzle, without causing strain or friction, the instant it receives a blow from the burnt powder, and thus offering little opposition, causes little recoil.

Action and reaction are doubtless alike, but the reaction on the moving power, from inert masses of similar weight put in motion by the said moving power, may be very different. No one will think that the reaction from starting an upright wheel is the same as the reaction from starting the same wheel when it is lying flat on the ground, or could be the same were its component parts in the form of a bolt lying longitudinally in the line of impulse.

As neither shot nor powder are retained long in the barrel, recoil is not a violent spring backwards, consequent on a projectile's sudden release from a state of severe restraint, but a more gradual, smoother motion, which in the experimental gun was effectively softened by being received on galvanized india-rubber sections of cylinders of same length, and same external diameter, but of gradually increasing interior diameter. This gradually decreasing strength made every section instantly take its own share of work. The resistance to recoil, slight at first, gradually increased. An arrangement was made for the force of the rebound being received in a similar manner by a simple self-acting mechanical contrivance, as shewn in the plans on the table. (See Plate II.) In a rolling sea, such a soft reception of the recoil and rebound might be found very desirable. Whatever may be the extent of the recoil, a many-toothed ratchet would retain the carriage, and thus husband the force of the rebound until released by the gunners to aid them in running out the gun when loaded. Clearly few men would be required to work the gun.

These sections of cylinders, designed as assistants to friction, might have been made of other elastic substance—of steel, or of a combination of cork with linen, after the ingenious plan once explained in this room by Mr. Clarkson. Whatever substance would best suit various

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climates would be employed as the material for the sections. I have this evening spoken to Mr. Clarkson on the subject, who says that no temperature affects the elasticity of his compound material, which, in his opinion, would answer well for the sections. He took from his waistcoat pocket a rectangular piece not much thicker, and of not much larger area than a dollar, which had been subjected edgewise to a pressure of four tons, yet had instantly returned to its first form, retaining its original elasticity.

Friction alone (with inclination up hill) does not sufficiently resist recoil when much powder is burnt. Many of us have lately seen large guns topple over when fired with no very heavy charge. The lower a gun sits on its carriage the better, for its tendency to jump is diminished by the line of resistance to recoil being nearly in the same horizontal plane as the axis of the bore; and when the low-seated gun is doing duty in the bow or stern of a vessel, it is the less likely to capsize in a rolling sea. This disc-gun could be placed on any ordinary carriage and have its trunnions fixed very low, for it is so short that but little depression of the breech is required to give considerable elevation to the shot.

It has been observed that the projected gun is peculiarly adapted to gun-cotton, and were that substance employed, we know that recoil would be curiously diminished. I use the term curiously, advisedly, for there is much difficulty in satisfactorily explaining the cause of the diminution. With ordinary guns, experiments carefully made in Austria showed, effect produced being in both cases equal, that recoil was one-third less with gun-cotton than with common powder.

2. *To be capable of throwing Projectiles of immense Weight.*

As the sharp-edged disc is projected so easily, and the recoil is so little, the size and weight of the gun need only be limited by the quantity of powder that can be fired with safety to the barrel and embrasure (or port-hole).

Thanks to recent great improvements in manufacture, the very short barrel can be made capable of withstanding any reasonable bursting tension. Mr. Whitworth's new process of subjecting cast-steel while in a fluid state to hydraulic pressure, thereby giving it the properties and density of wrought steel, may add immensely to the strength of barrels. The bore of the proposed gun may therefore be of great size, and as its diameter is the measure of the minor axis of the disc, it follows that the disc may be of immense weight. Calculation shows that did the bore suit a spherical shot of 100 lbs., the weight of the proposed disc would be 674 lbs., that is, more than six and a half times as heavy, although fired from a lighter gun.

And with regard to the firing injuring the embrasures, does it not seem probable that this gun would be found, compared with other guns, to cause but little damage? The gas is not poured forth in the powerful concentrated stream in which it first issues from the barrel.

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By being diffused over the large space within the muzzle before it quits the gun, its power to injure the embrasure is proportionately lessened.

3. *To have much Initial, as well as Sustained Velocity.*

We know that spherical shot have a much higher initial velocity than cylindrical. Hence the excellent performance of the 68-pounder within a range of 600 yards. I before mentioned that, conditions being as similar as circumstances would permit, Mr. Woollcombe found his circular-edged disc had far greater initial velocity than the sphere; and manifestly the sharp-edged, from its shape, would have more initial velocity than the flatter edged disc.

The experimental gun, imperfect as it was, with only six ounces of common powder, threw a sharp-edged disc eleven times the weight of the powder, a distance of 2,000 yards first graze. The chamber (or barrel) would hold no more. It would have been gradually deepened had not the muzzle cracked.

Considering the little powder used,—that it was ignited through only one touch-hole, and that the powder was not of a quick burning character, but the ordinary sort purchased from Government,—apparently great initial velocity was obtained. This velocity seemed principally attributable to the disc's not having to force out a column of condensed air packed in its front, to its sharp-cutting form, and to its being in a position to fly off with rapid rotation—a rotation which, being round the disc's shortest diameter, increased, it is thought, its velocity, from its climbing action on the air. When the trial was made there was so little recoil that had the amount of powder been, as is usual with many large guns, as great as a manageable recoil would permit, it is hard to say what range might not have been obtained.

The velocity of a sharp-edged disc is sustained for an unusually long period, because, from its wedge-like form and vertical rotation, it cuts a way through the air in the same manner that a vessel of fine-run cuts her way through the water; and also because, in the same manner that water presses inwards towards her stern and aids her progress, the air presses inwards on the sloping sides in rear of a sharp-edged disc and greatly diminishes the vacuum.

The area of a spherical shot taken through its diameter, and of the described disc taken through its minor axis being alike, it is computed that the vacuum will be less in the disc, from the shorter distance the air will have to travel to fill up the vacuum, than in the sphere in the proportion of about 5 to 8. Hence it is inferred that that particular cause of retardation will be mitigated in the disc to that extent—yet the disc will be more than twice the weight of the sphere.

Dr. Hutton says to the effect, that with a sphere no vacuum can be more complete than that caused by a velocity of 1,500 feet a second. It is then at its maximum—greater velocity would not increase it—but with the disc, retardation caused by a vacuum is not at a maximum until a velocity of 2,400 feet per second is obtained; yet,

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from the inability of the rifle system to meet the requirements of heavy ordnance, some thinking men have recommended a return to spheres when under the necessity of projecting heavy shot. Surely discs would be better. Pray bear in mind not only the advantage of a fine over a bluff entrance into the air, but the fact that, weights being equal, the sharp-edged disc presents only about $\frac{1}{4}$ as great an area to the resistance of the air as does a spherical shot.

To attain long range all projectiles must be fired at a high angle. Many artillerists think that the long axis of elongated projectiles remains during their rotation parallel to the direction in which they were fired; consequently the greater from the point blank line is the angle at which they are fired, the greater is the resistance offered by the air; whereas the disc during its whole flight presents but one quantity, its transverse area, to be resisted by the atmosphere whether the distance traversed be long or short.

It has been argued that owing to the shortness of the gun, and the expansion of the gas the instant it leaves the muzzle, the disc cannot have good initial velocity. In reality, however, the large surface presented by the disc will have been acted on, in the direction of the first impulse, for some time after it leaves the muzzle before the gas can much expand. On a dark night this is well exemplified to the spectator who watches the firing of a gun or rifle. When too snow is on the ground, and there is no wind, it may be seen that the unburnt grains are not dispersed laterally, but lie in the direction of the line of fire.

We should see the cheeks of embrasures blown away whenever guns are trained much to one side, were there immediately much lateral expansion.

4. *To stand large charges of Powder.*

Diameters of bores being alike, the proposed gun, from its short barrel, must be more able to stand a bursting strain than a gun of the usual length, for the barrel is virtually no more than the chamber, from which the gas is instantly liberated by expanding into a space of more than twice the area, viz., the enlarged muzzle.

As before observed, it is the resistance of a projectile to expulsion, that by confining the gas strains a gun when much powder is burnt, but the sharp-edged disc by rolling out easily, and readily entering the air, at once liberates the gas.

Short as is the barrel, were gun-cotton employed, it would be still shorter, therefore much stronger, for the surface acted on by the bursting pressure would but little exceed the surface acted on by the propelling pressure.

5. *To load, however large, with the ease of a Breech-loader.*

The barrel is so short that the gun may be regarded almost as a breech-loader. This shortness of barrel gives great facilities for

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quickly cleaning it, and ensures the gunners from all danger when sponging and loading rapidly. The arrangements for loading and working the gun are so simple that the most inexperienced hands could readily manage it. The charge of powder is inserted by hand. The disc is easily rolled home, and the alignment of the part not buried in the muzzle, instantly shows whether it is fully rolled home, and therefore locking on the catch.

In the excitement of action the worst that could happen would be the disc's expulsion without receiving rotation. There could never be a jamb. Under certain circumstances at close quarters, there might even be an advantage in the disc's being projected broadside on.

6. *To be handy—not to heat quickly with rapid Firing.*

From the gun being unusually light it is easily handled, and it is so short that it could stand conveniently in a turret. The muzzle would not project beyond it. Regard being duly paid that the cheeks be not injured by the gas, the port-hole would be a vertical aperture but little wider than the minor diameter of the disc, and but little higher than its major diameter, for in so short a gun, alterations in elevation would alter but little the position of the muzzle. A funnel could be contrived for carrying off the smoke. The ship whose guns can be served quickest, has an immense advantage at close quarters, and the disc leaving the muzzle the very instant the trigger lanyard is pulled, will, at all distances, be much valued by the Captain of the gun. From the gas soon escaping from the barrel and there being but little friction, the barrel would not suffer from heat in the most rapid firing. It has been stated that it is peculiarly suitable for gun-cotton, and as its ignition produces no smoke, it is to be wished that gun-cotton could always be burnt in whatever kind of gun may be used in turrets. From the result of experiments made in Austria, it may be inferred that the most energetic attempt to injuriously heat the proposed short barrel would utterly fail. In continued rapid firing with heavy ordnance, one disc gun would throw more shot than three rifled guns.

7. *To present a large surface for the Gas to act on.*

In ordinary rifled guns the gas expanding in the barrel acts but upon a small surface of the projectile. In the proposed gun it expands in the enlarged muzzle and acts directly towards the disc's expulsion on an area greater than twice that of the cylindrical barrel. The surface acted on is always proportionate to the weight of the disc. This, as before stated, is not the case with cylindrical shot. Were the disc fixed water-tight within the muzzle at a short distance from the barrel, and the interior of the gun subjected to an hydraulic bursting pressure, the pressure on the disc would be measured by the area of a section taken through its minor axis. In the same manner must the expelling pressure of the gas be estimated. This truism is ventured on, because the remark has been made, that the gas could not exert

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its full expelling power on the disc, in consequence of meeting its sharp edge.

8. *To have the vacuum in rear of the Projectile, but little increased by adding to its weight.*

As the sloping sides of the sharp-edged disc remain at the same angle, however much the weight of the disc may be increased, additional size and weight, comparatively speaking, add but little to the vacuum.

9. *To have good Penetration when striking obliquely.*

The rapid rotation of a disc in a vertical plane seems to give it a tendency to adhere to, rather than glance off, any object it strikes. Therefore, as a turret can be increased in thickness to any extent, bearing as it does but a small proportion to the size of the ship carrying it, might it not be judicious, neglecting an almost invulnerable turret of a monitor, to attack her in her most vital part, viz., that part of the deck in contact with the turret, where any injury might create a jamb and prevent its revolving?

No projectile seems so likely to effect this injury as a vertically rotating disc. The resistance made by the gyroscope to any deviation from the plane in which it is rotating, shows that the disc if started vertically will strike vertically.

10. *To make a large Aperture when it penetrates.*

This aperture cannot be less than a section of the disc taken through its minor axis, an area obviously far greater than a transverse section through the minor axis of an elongated cylindrical projectile, weight of disc and projectile being alike. Caused by a heavy disc, it will be an unpleasant chasm between wind and water, to plug up in the heat of action!

11. *To throw a Shot which will cut its way through Water.*

A spherical shot, as long as it has any velocity, will ricochet time after time upon water. So will a round-headed cylindrical shot, but from rotating round its longest axis, it always glances off at an angle. This was painfully exemplified in 1864, at Plymouth. An Armstrong shot fired from the citadel, ricocheted at a considerable angle from wave to wave, all which unfortunately met it obliquely, until it finally struck a boat, and unhappily killed one of her men. Possibly some here present may remember that it led to my being tried at Exeter for manslaughter, and being placed, as a local paper triumphantly announced, in the "*felon's* dock." It was argued that being in Command of the District, I ought to have foreseen the danger, and forbidden all artillery practice in the Sound.

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To enter water without ricocheting, cylindrical shot as Mr. Whitworth has shown must be flat-headed, a form directly opposed to progress. The rapidly vertically rotating sharp-edged disc, enters water and penetrates through it for some distance, without deviating from the plane in which it is rotating. With a rotation contrary to that of a progressing wheel, it would bury itself in water. By experiments made with a gun laid at low tide, and fired at high tide when it was completely covered with water, it was shown that double the ordinary bottom of a ship could be penetrated by a shot passing through 30 feet of water. As this was effected by a spherical shot, starting from a state of rest *in water*, it seems reasonable to think that a sharp edged disc entering the water with great velocity ought to have sufficient power to pierce a ship's bottom through more than 30 feet. A ship carrying such a gun might destroy her antagonist when rolling in a heavy sea, unless she was protected with thick plating to the very keel.

Were a small swift vessel furnished with but one light disc gun, to get near the largest iron-clad in a fog or a dark night, it is thought that the small vessel could destroy her large antagonist by firing no more than one water-tight time-fused shell with good aim below the armour plating.

But the adoption of the disc gun need not necessarily lead to the abandonment of ricochet firing at sea, which many sailors regard as most useful. Were the gun laid on one side, the disc would be projected horizontally, and would ricochet often, judging from its form. Most of us, when boys, have selected stones much the shape of the proposed disc to make "ducks and drakes" on the water, and when we have given them a good spin and thrown them horizontally, have been delighted with the length and number of ricochets we have succeeded in making on the surface of a smooth pond. Manifestly, however, the initial velocity of the disc fired horizontally, would be somewhat less than when fired vertically, for although the gas would not be forced to drive it through rifling, there would be the recumbent inert mass to set in motion.

Were the proposed disc cut longitudinally through its periphery, and one-half placed horizontally (flat side uppermost) in the muzzle of a gun cast for the purpose, it seems probable that an immense range could be obtained. Its rotation would keep it in a horizontal plane. The precision might not be good, but harbours and dockyards could be attacked from great distances.

12. *To be admirably adapted for enfilading Ricochet Firing.*

The rotation given to elongated projectiles being at right angles to the axis of projection, they necessarily, after every graze, make a considerable deflection in the direction of rotation, hence enfilading ricochet firing to sweep parapets, becomes very uncertain work with such projectiles; whereas the rotation given to the disc, coinciding with the axis of projection, the disc on striking the ground would not

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diverge in the least, but ricochet for a long time in the direction of its first flight. This is well illustrated in the Japanese spinning-top, which, when it alights on one side, runs at a rapid rate along the ground. Rotation seems but little diminished in the longest flight. There are no buttons or projections on the disc from rifling to meet the air and thus gradually lessen rotation.

13. *To be peculiarly well suited for Vertical Firing.*

A mode of firing which many artillerists are of opinion must be more and more resorted to as defensive armour becomes more and more strengthened.

It was this plunging fire that recently destroyed the Danish cupola ship, and at Charleston the "Keokuck."

The proposed gun is obviously peculiarly fitted for vertical firing, as from the constant rotation of the disc in a vertical plane during its whole flight, some part of its edge must unavoidably impinge upon the deck, or building, or on whatever it falls. Gravity will bring down the disc, but as gravity would not act on rotation, it seems more than probable that when started with good rotation, rapid rotation would not cease until the disc struck. A penny piece thrown up into the air spinning will alight spinning. Against such a shot, if heavy, it would be difficult to make any buildings bomb-proof, and even should it alight on bare ground, as rotation, consequently progression, would continue, it might still inflict much mischief.

14. *To be capable of throwing Red-hot Shot, and Shells carrying Molten Iron.*

It is obvious that this formidable material cannot be kept for any time in a projectile coated with lead, or any soft substance that would melt. In the disc it could be conveniently carried, for its two flat sides are subjected to so little strain that they might be made very thin, thereby affording ample space for the molten iron, or for the insertion of Armstrong's beautiful shell arrangement. The cylindrical time-fuses and concussion-fuses would be increased in diameter as they decreased in depth. The segment-shaped pieces of iron would be in successive concentric layers, instead of being piled in successive layers, and the cylindrical cavity in the centre (containing the bursting-charge) would make up in width what it loses in length. The zone (if it may be so termed) of the shell would be cut into thin laminæ parallel to the largest plane, and be slightly scored on their inner circumferences. These, screwed together (waterproof cement being interposed), would shiver into numerous pieces on the explosion of the shell. For security, each lamina might slightly overlap the edge of its contiguous smaller neighbour.

Many cylindrical shells are liable to explode towards the rear. The zone of a sharp-edged disc shell, made of Palliser's chilled iron, might

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be cast so thick and strong that the chief explosion would always be in the most destructive direction, viz., laterally, for clearly that would be in the line of least resistance. The disc gun would act capitally as a mortar.

Few rifled guns can throw red-hot shot. They have occasionally burst even smooth-bores. This accident could never happen to the proposed gun—its shortness would prevent it.

15. *To be Inexpensive.*

There is no difficulty in constructing the gun, and the little metal employed, compared with the weight of the disc, shows that the gun will be inexpensive. Its durability, too, would, in the long run, make it singularly inexpensive.

16. *To be Durable.*

It *must* be durable, for, after it has stood the proof, there is nothing that can shake loose; there is nothing that can get out of order. When fired there can be no strain from the pressure of confined gas; it is free to instantly expand in the enlarged muzzle. The barrel or chamber is so short that metal need not be spared in strengthening it, with the object of making the gun light.

Used as a light field-gun, it might be made very effective against cavalry. Let the disc be formed of numerous thin laminæ, cut parallel to the largest plane. On each side of the centre of the central lamina, attach a cone (made a little oblong) the height of half the minor axis of the disc, the diameter of the base of the cone twice its height. Corresponding holes being cut through the centre of the other laminæ, the whole can be fitted together, and fired *horizontally* as one disc. The laminæ will fly off the cone and spread like a pack of cards thrown with a twist from a conjuror's hand. Fired vertically, they would separate, and trundle along in slightly diverging directions.

To make the gun project into an embrasure, there is no reason why the muzzle should not be lengthened; but from its lightness and compactness, the gun, if furnished with Captain Moncrieff's most ingenious carriage, as described in number XLI. of the *Journal of the Royal United Service Institution*, seems peculiarly suitable for the upper decks of most ships not port-holed. In lieu, however, of the counterbalancing weight, which might be disadvantageous, I would suggest the practicability of substituting strong, upright, spiral springs, resisting extension at the front of the rounded elevator, and resisting compression at its rear.

The lower extremity of each spring would play in a fixed eye, in order that the other extremity might follow the arc described by the elevator. The useful action of these springs would be found precisely the same as that of the weight. "The force of the recoil" would be "gradually met by resistance, rapidly increasing as the gun" reached "its lowest position;" *vice versâ* after the catch was released, and the gun raised into firing position.

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This substitution of comparatively light springs for the heavy counterweight would, when the gun was in use, render it the less liable to roll over in stormy weather.

In case of injury to a spring, or in climates where the springs would be affected by intense cold, a box filled with spare shot might temporarily take the place of the springs. It is presumed that a few spare springs would always be kept in store.

When the sights are fixed on one side of the gun, a small, light shield might be attached at an angle to the carriage that would protect the gunner from the direct fire of musketry at the least.

The principle on which the disc-gun is constructed, admits of very extended application. The recoil is so trifling that it seems probable a formidable weapon, to be fired with a rest from the padded shoulder, could be made so light as to be conveniently borne by a mule carrying a good load of suitable ammunition; and that for a sportsman to kill "burra shikar," *large game*, a handy, yet most destructive disc-gun could be easily built.

What a cheap, convenient wall-piece might be constructed for destroying the thickest gabions and sap-rollers! Indeed, as the disc ricochets greatly, and never deviates from the line of aim, were not "fixing bayonets" a puzzler, I should be tempted to say that the ordinary weapon of the soldier might be constructed on this principle, and that he ought to be carefully instructed to fire extremely low when from smoke or other causes he cannot take a cool aim.

The light brass experimental gun I had made, was somewhat similar to the plan but with *much* less proportionate metal at the junction of the barrel with the enlarged muzzle. It threw a disc shot of above 4 lbs. Owing to the metal being too thin where I have described, the gun cracked at that part, the first trial-shot that was made from the gunnery-ship at Devonport. Possibly the metals forming the cast were not mixed in judicious proportion. The gun was then strengthened with a hoop over the crack, but insufficiently. Moreover, the bolt forming the catch got displaced, owing to its having been screwed in, parallel to the bottom of the muzzle instead of through it transversely. The trials, however, though necessarily very few, from the fracture increasing, appeared fully to establish that the disc rotated rapidly—that the direction was good—the recoil little—and, under the circumstances, the range most satisfactory.

The trial was witnessed by many Officers, who expressed great surprise that a gun so light compared with the weight of the shot should perform so well. The Officer commanding the Gunnery-ship, and the Officer commanding the Royal Artillery, were subsequently asked to give a certificate as to its merits.

I will read you what they wrote:—

(Copy.)

"H.M.S. 'Cambridge,' 12th December, 1864.

"I was present when Major-General Hutchinson's gun, throwing a "disc-shaped projectile, was fired from H.M.S. 'Cambridge.'

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"Three shots were fired. Projectile weighed 4 lbs. 2 oz., powder "6 oz. The first shot at the 1,000 yards target was very satisfactory, "the direction excellent. The rotation seemed to be perfect. The "shot passed a short distance over the target.

"The two next shots were indifferent, which I attribute either to the "projectile not being properly fitted to the gun, or else to the gun itself "being injured.* So long as the rotatory motion can be preserved, I "see no reason why great accuracy should not be obtained in striking "an object.

"C. F. J. Ewart,
Captain H.M.S. 'Cambridge.'"

(Copy.)

"Royal Artillery District Office, Devonport,
12th December, 1864.

"I was one of the spectators when the disc shot was fired from "Bovesand in the direction of the Shag Stone Rock. The weight of "the disc was 4 lbs. 2 oz., that of the powder 6 oz. The estimated "range was about 2,000 yards, before it touched the water. There "was no ricochet.

"A. A. Shuttleworth,
Colonel Commanding Royal Artillery,
Western District."

Addressed as you often are from this table by really scientific men, however satisfied I might be in my own mind that the proposed gun possessed the principal advantages of both rifle and smooth-bore systems, it might be presumptuous in me to appear before you this evening, were it not for these favourable testimonials.

Some of you may think that if I so fully believed the gun could prove useful, I ought as an old soldier, to have proffered it to Government. I considered such to be my duty, and I accordingly offered them the free use of the patent. I thought there was a chance of its being accepted, in consequence of the satisfactory certificates given by Officers whose opinions would carry weight, although I had no gun to submit for trial; yet I ought not to have expected that, with a proper regard for the public purse, Government would ever be advised to make experimental guns for inventors. Were an exception made in one instance, many would be offended.

I had never heard of Government manufacturing for any one; and having been President of the Small Arms Committee, I have been a good deal behind the scenes. The endeavour to satisfy those who forward for trial, arms and ammunition complete in every respect is hard work. In two years, while I was connected with the Small Arms Committee, we reported on, if my memory serves me right, 36 specimens of well-finished breech-loaders.

* It was subsequently found to have cracked.—W. N. H.

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The number of inventions that would be submitted, *on paper*, with well drawn plans and descriptions, would be endless, and the resources of the present establishments quite insufficient, did Government undertake to manufacture specimens at the expense of the country.

At one moment I thought of building another trial gun myself, but circumstances needless to explain prevented me, and it was not until the arrival of the "Miantonomoh" that I again reflected on the necessity that seemed to exist for our being provided with ordnance able to discharge projectiles of really great weight with good initial velocity. I fear some of you may think I *ought* to have built another gun, and not have consented to appear before you until I could give more proofs of the capabilities of this kind of ordnance,—yet the certificates (corroborated as they might have been, had I wished it, by the testimony of many witnesses) that I have just read to you, from Officers in highly responsible positions, and whose characters are well known in the Service, prove that the project is not one of mere theory, but has stood the test of a fair though short trial. What a gun has done once, it will do again and again under similar circumstances, and you have unquestionable evidence that the trial gun, imperfect as it was, and radically wrong in the position of the catch, gave proof, though fired with only ordinary powder but $\frac{1}{11}$th the weight of the disc, through but one touch-hole, gave proof, I say, of both accuracy and range; and I can state from my personal knowledge, that the latter was obtained when the gun, though repaired, was in very bad condition.

If violent concussion from a heavy sharp-edged, rounded, or flat-headed projectile (all the edge is one head) with rapid rotation—a rotation too that tends to prevent, instead of aiding its glancing off the object struck—be required to smash the armour-plating daily made of increasing thickness, it seems proved that the proposed gun, which is easily constructed, is well calculated to furnish such requisites to almost any amount, and at comparatively little expense. I am far from fancying that my proposition may not be improved on in its minor details, but I contend that it is on this general principle, ponderous shot ought to be projected. With heavy ordnance I contend—from saving of strain to barrel, and non-diversion of gas to procure rotation—that the simple plan I have suggested for obtaining rotation by a catch, is preferable to any system of rifling; and that for many purposes a sharp-edged disc is a better form of projectile than a sphere, or any modification of a cylinder.

I subsequently devised a plan by which gun-barrels, and all cylinders subjected to great strain from within, might be strengthened to any extent, but as the gun, although the trouble of shrinking one cylinder over another was avoided, would be expensive in manufacture I will not enter further into the subject than to say that the plan is peculiarly applicable to hydraulic presses, and that the well known firm of Eastman, Amos, and Sons, after considering the principle of construction were so convinced of its correctness that they said they would try the plan, were they ever engaged in a large work, such as the Menai Bridge. Each of the series of cylinders forming the press is made to do as much useful duty as the innermost. This is effected by a calcu-

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lated pressure increased successively from the outermost, upon each of the cylinders of fluid (so to call them) interposed between the metal cylinders. The pressure upon each cylinder of fluid (imparted by a small piston and spiral screw) acts as a support to the contiguous inner cylinder of metal, and is ultimately transmitted as a support to the innermost. The plans of a gun throwing a 1,000 lb. spherical, or a 3,000 lb. cylindrical shot, and of an hydraulic press, with the explanations and calculations, are in this room, but there is so little time I will not ask you to look at them.

It may be thought extraordinary by some who have not reflected on the subject, that I should advocate the introduction of guns I consider would prove so destructive—but there is humanity in efficiency. However paradoxical it may sound, all history shows, that the better the arm, the less the slaughter. The protracted warfare of the savage is one of extermination. Instead of having a thirty years war, the needle gun terminated a campaign in thirty days. Ships would not be recklessly brought into collision, did they carry such cannon, that a well directed shot from each, would probably sink both the combatants.

I thank you heartily, Mr. Chairman and Gentlemen, for having listened to me so patiently, and allowed me to take up so much of your time. The system I have suggested is such an innovation upon established theories and long usage, that I am not so unreasonable as to imagine it can at once meet with your approval, but I am sanguine enough to believe that the more you are pleased to think over the design—the more you reflect on the reasons that caused the badly proportioned, the only experimental gun ever tried, to perform so well, —the more you will be of opinion, that for many purposes the principle of construction I have endeavoured to explain, possesses important advantages.

The CHAIRMAN: After the very lucid statement we have heard from General Hutchinson of his invention, I hope that some gentlemen here present acquainted with gunnery will favour us with their observations upon the subject.

Vice-Admiral J. H. CODRINGTON, C.B.: One question I should like to put to General Hutchinson. Will he be good enough to explain how his gun would be placed on board ship? That is to say, considering it is very short, how it would be put in position to be efficient, and yet to project sufficiently so as to throw its shot clear of the thickness of the side of our present ships?

General HUTCHINSON: My idea was, that it was so thin a shot, going so much on its edge, that the embrasure or port-hole would be much narrower than for an ordinary gun.

Admiral CODRINGTON: I was speaking more of the actual length of the gun. The thickness of the ship's side would be almost as much as the length of the muzzle of the gun. Supposing the gun to be supported on trunnions, where would the carriage be? Inside the ship, or suspended in the port?

General HUTCHINSON: The carriage would not be much longer than any ordinary carriage. Besides the check there would be to the recoil from friction and from the inclination upwards, there would be the elasticity of the india-rubber sections of a cylinder. They would all check recoil. There would be very little. I remember Colonel Maberly, R.A., said he could not understand how there should be so little. He observed, "With a gun so light, and shot so heavy, how is it there is so little recoil? All the shot seem to roll out easily."

Captain STRANGE, R.A.: Without wishing to be at all censorious on General

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Hutchinson's very excellent and lucid remarks, I am only surprised that they have not attracted more attention. But there is one point I should like to remark upon. It is, that the capacity as a shell for powder, of the disc form of projectile would not equal the capacity of the cylindro-conoidal. That to a great many minds is a drawback; because ricochet firing having been lost to artillery, as General Hutchinson has said, since the introduction of rifled ordnance, they have resorted to, and hope in future operations to depend more on the bursting charge of the shell. That small exception, I think, is almost the only point for the General to consider.

Lieut.-General HUTCHINSON: I thought that in the disc shaped shot the explosion would be altogether lateral; that there would be no fear of any discharge either in front or in rear. I thought that the sides of the shells might be made so thin that there would be ample space for the fulminating powder.

Captain STRANGE: It might be so; there would not, however, be the same amount of space. But that does not take away from its battering or ricocheting advantages. It may, perhaps, be less useful as a shrapnel shell. The spread would be lateral, and the balls of the shrapnel should have a forward action. I mention these two points, because if I can find so little to comment upon, not, I must repeat, in a spirit of censoriousness, I am only surprised that the plan has not attracted more attention.

Lieut.-General HUTCHINSON: It may seem presumption in me to address you at all upon this subject, not being a gunner; but I have thought a good deal on this subject all my life.

Captain SCOTT, R.N.: If you will allow me, I would say there is one point certainly that I, in common with many others, have listened to with a great deal of pleasure; and if it were more generally imitated, I think it would very much add to the results which the country would obtain: I mean the very generous way in which General Hutchinson has spoken of Mr. Woollcombe. I am sure we were all very much pleased with the way in which he spoke of Mr. Woollcombe, giving him most of the credit, speaking only of what he himself had done, putting Mr. Woollcombe in the fore front rather than himself. It has just been remarked, that what we want in a shell, is powder capacity. I must say myself, that one of the chief desiderata in connection with naval projectiles, is that of capacity; that unless we have a capacious shell we cannot afford to give up the ricochet of the round ball; we cannot afford to give up its many advantages without some compensation. At the present instant all the projectiles that are being made for battering purposes have little or no powder capacity. The present nine-inch chilled shell holds only 2 lb. 13 oz. The seven-inch gun has no battering shell. So that powder capacity, at present, has been in a great measure sacrificed. If General Hutchinson with his projectile, can get a fair capacity, and at the same time penetration, and the projectile does not fly off on striking at a moderate angle, he will have obtained a very great advantage indeed. But it seems to me that what the disc projectile is specially adapted for, is precisely what the General says, for vertical fire. Our vessels at the present time are all of them assailable by vertical fire. There is no protection against it. The decks are thin; a huge projectile falling on the deck would undoubtedly go through their bottoms. Then I think a still more valuable property will probably be that of firing under water. In the gun shaped as General Hutchinson has described, you have but to drop the shot in and fire. I believe that in future warfare we shall see guns fired continually under water. I believe that firing under water will be one of the most formidable means of attack as an addition to the torpedo. I think we must look to being assailed by the torpedo craft in all operations. We shall always have to be the attacking force, therefore our ships will be eminently liable to the operations of the torpedo. I believe that the effect of loading the upper sides of our vessels with armour, and leaving the parts under water unprotected, will be, that they will be speedily sent to the bottom. Although I do not quite agree in many points that General Hutchinson has stated, yet I do agree most fully in what he has said of the projectile rolling over, and the ease with which it is expelled from the gun. With our heavy guns of the present time, the interior of the gun gets heated, and is soon destroyed, to an extent, I believe, that very few are aware of. It becomes after a time like a ploughed field; and what General Hutchinson says of his gun not heating,

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and not being destroyed, is undoubtedly true. In the first place, the disc-shot, in common with the round ball, which I confess I have still a weakness for, rolls over very easily, and will, therefore, be expelled from the gun very easily. Now, there will be a great advantage in that; that the gun will not recoil in the same violent way. Again, and this is a thing we have not tested with very heavy rifled guns, is the effect upon the gunner at the port. This gun will show a decided advantage in this respect. The only experiments I have witnessed of firing heavy guns together was in the "Minotaur," and, subsequently, in the "Bellerophon." In the "Minotaur," firing 150 lb. round balls from 12 ton guns, I found that I could stand at the port very comfortably; but with the rifled 12 ton gun fired from the "Bellerophon," it was very uncomfortable, indeed. When you come to fire a heavy elongated shot, the gas from the powder is raised to a very high temperature, and it expands on all sides. I believe the effect of it will be a very serious thing. There is another point that certainly is in favour of a disc or round shot, which is this. When we are in action, it is to be hoped we shall not play at long balls, but shall at once go in at the enemy, as we did of old;—because being the attacking force it has given us the victory, and it will always give us the victory; directly we come to act upon the defensive, we may give up the game at once—whilst we are the attacking force, we shall constantly find that the elongated shot, impinging against the water, will fly off at a tangent, and instead of striking the enemy, will very likely go on board a friend. What with studs coming out of the shot, and what with the tendency of the shot to fly off right and left, I believe we shall have plenty of accidents. Hardened or chilled shot, we know, constantly break up at the muzzle of the gun. Therefore, let us have something that is safe for ourselves to begin with. One does not like a gun that goes off at both ends, nor a shot that breaks up and strikes your friend as well as your enemy. Therefore, I say, let us have the round ball or disc. I think I have shown some points in which the disc is really valuable, and I am sure that General Hutchinson deserves every credit for his success. We may find the disc shot turn out to be more valuable than was thought possible before we heard his explanations.

Commander W. Dawson, R.N.: Some six or seven years ago I had some experience in experimental firing on board the "Cambridge" with disc shot, similar to that of General Hutchinson's. Certainly, the range we obtained from it was very considerable considering the means we employed. The disc employed was that of Mr. Woollcombe. Speaking entirely from memory, and merely to give you an idea of the general dimensions, I may say that the shot was about 1 lb. in weight; the charge of powder was two or three ounces, and the gun was a very small gun, which was fired from a height of about twelve feet from the water's edge. I think we fired it at an elevation of one degree. It gave a range of about 700 yards. I had an idea that this disc shot, although it might give a very good range, could not possibly give a good direction unless the disc was perfectly vertical. In order to test these points, Mr. Woollcombe, who loaded the gun himself, gave the carriage of this gun a heel of about four or five degrees; he laid the gun again at the same mark, and it went four, or five, or six hundred yards to the right of the mark. The number of shot Mr. Woollcombe had was not great; but we repeated that experiment, and the shot went again in the same extraordinary direction. It exactly confirmed the theory in my own mind, that the plane of the trajectory of the shot must be exactly vertical, and that in order to get accuracy out of the disc-shot, you must quadrate your gun and lay it with a spirit-level across the trunnions. That is a very serious difficulty, which probably can be overcome for experimental purposes on land; but it is perfectly impossible to overcome that difficulty on ship-board, even in the smoothest water. The decks of a ship are not like the flat plane of a battery on shore; and when the gun is extreme trained, even in smooth water, it is thrown out of its quadrature one or two degrees, as the case may be, and depending upon the inclination of the deck. So that it is impossible even in smooth water, and of course, when the ship is heeling a little by the action of the wind, it is still more impossible to get over that difficulty. So I am afraid my experience with reference to accuracy differs somewhat from Captain Ewart's more recent experience. I speak only from memory. I think I understood from Mr. Woollcombe the way in

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which he got at this disc-shot. It struck me as rather peculiar. It was rather the result of accident than of calculation. He said he was looking for the proper and best form of projectile, and he thought he would find it in some bodies of nature. He thought, perhaps, if he studied the planets he would find among them a planetary body which presented the best shape for projectiles, and he thought the planet Jupiter would do. But he found it was rather difficult when he reduced the planet Jupiter, to get it into a gun. He then shortened the minor axis; he found still that the shot had a tendency to turn upon one side, and to jamb. He then took a sphere, and he cut a slice off one pole, and a slice off the other pole; and thus we get the form of the disc-shot which we have before us, without the sharp edge, but with a curved edge. That was the particular disc to which he confined his experiments. He got rotation, not by the "catch" plan which General Hutchinson has now introduced, but by altering the centre of gravity of the shot, by boring a small hole on one side. And his gun was not similar to General Hutchinson's gun; but it was the ordinary long gun, with the bore shaped to receive the disc. The way he got the gun made, on this occasion, was by simply filling up a cylindrical bore with two cheek pieces, one on each side. That was only a temporary arrangement for that particular gun. The other points brought forward by General Hutchinson are quite different from what Mr. Woollcombe then brought forward, especially the short gun which General Hutchinson has introduced. I do not think that the General quite understands Admiral Codrington's objection. It appears to me that Admiral Codrington wishes to get the muzzle of the gun outside the ship before firing it. That was the objection which I think was not exactly understood; and it is a serious objection for ship purposes.*

Lieutenant-General HUTCHINSON: It would not apply to a turret.

Commander DAWSON: Still the muzzle must always be external to the ship. I dare say the difficulty is to be overcome; you can make your gun longer. I do not see why you should restrict yourself to a short gun.

Lieut.-General HUTCHINSON: There was only one gun that was ever tried. Unfortunately it was too light where the enlarged muzzle was joined to the short barrel. Captain Ewart knows the excellent shot he made with it. It went over the thousand yards' target. I had it hooped up afterwards, but we are always liable to meet with accidents with first guns.

The CHAIRMAN: The thanks of this Meeting are due to General Hutchinson for having brought forward this project. I think you will agree with me, now that he has laid this system before the meeting, that it will have the effect of turning the attention of the Authorities to it, in order that it may receive those trials which he himself ardently courts.

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* General Hutchinson, finding that he had omitted to notice Captain Dawson's argument, is anxious to state that it appears difficult to think how the deviation can be attributable to the cause suggested, as the action of the air on any side of the cylindrically rotating disc will not be altered, whatever may be the plane in which the disc rotates. There seems no reason, apart from gravity, why the shot should deviate more from the prolonged axis of the bore of the gun in one instance than in the other. He also desires, further to state in answer to Admiral Codrington's query that the gun would be inside the port, the muzzle might be much lengthened, yet be light, for the bursting force of the gas is diminished by being spread over a space of greater area than the barrel, and as the unopposed shot would be flying out with great velocity, the gas, without straining the sides of the gun, would relieve itself by following the flying shot.—ED.

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"ON THE WORKING OF HEAVY BROADSIDE GUNS."

By Andrew A. W. Drew, M.A.

It is exactly two years ago, within a day, since I had the honour of reading a paper in this Institution, entitled "A few rough ideas for "the Construction and Arming of Iron-clad Ships of War."

Since that time very great progress has been made in the art of manufacturing armour plates and chilled iron shot, but from all I have seen and read, very little has been done, either in the improvement of naval guns, or in the method of working them upon the broadside. Two years ago, the 12-ton Armstrong gun was the most effective weapon possessed by any English ship of war, and I believe I am not wrong when I say it still holds its position.

Those of you who were present in this room on the 5th of February, 1865, will remember that I proposed a method of working these 12-ton guns upon the broadside, which method, if it were adopted, would secure many advantages not possible in any existing plans, and would remove many disadvantages which mar their effect.

On that occasion I did but touch lightly on the plan for working the guns, the description of which plan occupies only two pages in the 9th volume of the Journal of the Institution, though, as may be seen by reference to my paper read that evening, that the scheme was then complete, as I shall present it to you this evening, with the exception of a plan which I have recently devised for running heavy broadside guns in and out, and this sees the light for the first time this evening.

Within the last few months I have had the opportunity of inspecting the three different methods of working 12-ton guns on the broadside, which have been adopted for competition in the "Bellerophon;" but, in my estimation, they are all open to the following serious objections.

1. They cannot give sufficient command over the guns, in a heavy sea-way, to insure their being worked with efficiency and safety.

2. They do not provide for any increase of lateral training, beyond that possessed by all broadside ships, viz., about 30° each way.

3. They do not afford so great an amount of protection for the gunners as the ordinary methods, inasmuch as the ports are larger.

4. The system of pivoting is weak, in two out of three of the plans, and exceedingly liable to become deranged in action. The plan adopted by Captain Scott is, no doubt, a good substitute for a pivot, but I do not think that it will be found possible to work 12-ton guns in a heavy sea, without the use of a *bonâ fide pivot*, much stronger than those in use, and perfectly protected from the chance of injury, and therefore to be depended upon under all circumstances.

I am fully aware that it is quite impossible to secure every good point for any one plan of training and working heavy guns, and that the question of superiority is only one of degree.

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The existing plans are good, until we find better. The question, therefore, is "what good points do we most require for the working of heavy broadside guns?"

I have already stated the principal objections which I make against the three competitive plans for working 12-ton guns, as fitted in the "Bellerophon;" and I think I can show that their defective points are, of all others, those to which the greatest amount of attention should have been paid.

I claim that my plan does not possess any of these objections, and that its drawbacks are not nearly so serious as those of the experimental plans; while its advantages are very much greater.

I ought perhaps to state here that soon after my appearance in this theatre (on the 6th February, 1865) I submitted my method of training heavy broadside guns to the late Admiralty, telling their Lordships that my plans were quite at their service, without fee or reward, should they desire to make any use of them. To my great surprise I was immediately requested to call at the Admiralty and explain my plans in detail. I had expected that, perhaps in a couple of months' time, I might receive some intimation of their Lordships' pleasure, but in three days from the time I despatched my offer they were in full possession of all I had to tell them. I was received at the Admiralty by the Comptroller and the Chief Constructor of the Navy, both of whom went carefully through the plans, point after point; and, at the conclusion of a long interview, the former gentleman informed me that the Chief Constructor and himself had formed so good an opinion of the plans proposed by me, that it was their intention to submit them to the "board," for adoption, or at least for competition with other plans. This accordingly they did; but, alas! some member of the board thought he saw a defect, and imagined that the port I proposed would weaken the side of the ship to an undesirable extent, though the Chief Constructor had allowed in my presence that this need not be the case. Indeed on actual measurement I found that my port did not require so much of the ship's side to be cut away as the present style of broadside port. Nevertheless, I was informed that the (supposed) objection was fatal to the adoption of my plans.

Upon receipt of this letter, I made an application to be informed as to the precise *grounds* upon which the objection had been based, as I had reason to believe that I could easily overcome it, and that further suggestions from me would be found to meet the objection.

Their Lordships thereupon commanded me to be informed that "they "could not take upon themselves to disclose the grounds upon which "their decisions were based, but would be happy to receive any "further suggestions from me."

Considering that I was not a professional inventor, seeking reward at their hands, I thought that their Lordships might at least have allowed me to know the precise nature of the objections they had discovered, in order that if they really existed, I might know in which direction to turn my attention. Not unnaturally, I declined taking any further trouble, determining that if I ever pursued the matter, I would await

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some fitting opportunity for coming here again, and inviting discussion among the scientific members of this Institution, upon the merits and demerits of my system of working heavy broadside guns.

I will now describe the general plan which I sketched out in my former lecture; first observing that the points I aim at securing are, perfect control over the gun, under all possible conditions; a large amount of lateral training; a small open port; a simple but powerful mechanical contrivance for training the gun which shall enable *one man* to keep the gun bearing upon its object; a similar contrivance for running the gun in and out, also to be effected by *one* man, in a very small space of time; and lastly, an adequate amount of protection for the crew of the gun and its necessary machinery.

These, it will be allowed, are all great advantages. I proceed to secure them by the following means:—

I first of all pierce the ship's side, and form what appears to be an unusually large port 4 feet wide and 6 feet high, the upper portion of which is circular, and the edges of which are square, *i.e.*, the port is cut straight through the ship's side, at right angles to it, without any beveling away inboard. I have been told that such a port would weaken the side of a ship to an undesirable extent, and, as far as I have been able to gather, this was the real reason why the late Admiralty did not adopt my plans.

The Chief Constructor had pointed out to me that this might be urged as an objection; but upon my asking him "whether he himself "believed my port weakened the side of the ship *to a greater extent than "those ports already fitted to certain broadside ships for 12-ton guns;*" he candidly confessed he did not think it was so.

The ports at present used for working 12-ton guns are very deceptive; they appear exceedingly small, when viewed from the outside, and, apparently, there is little room for the admission of shot or shell, but the fact is the ports are only small to look at. The edges are beveled away inside, so that there is nothing left except the external armour plate, to prevent the free admission of shot; the backing is all cut away, and practically the ports are very large.

I will, however, suppose that the present style of port is as strong for defensive purposes as it looks from the outside; and will grant to it all the merit it can claim on this score. From actual measurement in the "Minotaur," "Northumberland," and "Bellerophon," I find that the smallest port yet fitted for a 12-ton gun has an exposed area of more than 9 square feet. The exposed area of my port is 4·283 square feet, or in other words, less than half that of the ordinary port; consequently, when I have shown that my small exposed port does not cause me to lose any substantial advantage possessed by a larger one, but does give me many advantages which they cannot afford, I think I have achieved something in reducing 9 square feet of open port to less than 4½. But, I apprehend, it was the supposed tendency to weaken the *structural* strength of the ship which was feared in the case of a port 4 feet wide; whereas, in truth, the port I propose cannot weaken the side of the ship so much as those already in use. It is very easy to say that my port is 4 feet wide, and the existing ports are little more than

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2 feet wide, and therefore that the former must cut into the side (or in other words weaken it) twice as much as the latter, but this is not true, for there is a certain law, known to every mechanic, that the greatest strength of any structure is the strength of its weakest part.

Now, inasmuch as the edges of my port are square from outside to inside, the total extent to which the ship is weakened, longitudinally, is represented by the width of the port, viz., 4 feet.

In the case of the ordinary port, the weakest part is to be found *inboard*, where, instead of 4 feet, the side of the ship is cut away to more than 5 feet, and this latter figure represents the real extent to which the side of the ship is weakened, for it must not be forgotten that the framework of the ship is *inside*, and it is the framework, and not the armour-plating or its backing, which gives strength to the structure. This being so, every inch which is cut away from the inside of the port, weakens the side of the ship to that extent; so that my 4 feet port, instead of being a source of *weakness*, as compared with the present style of port, is exactly the contrary in the proportion of 4 to 5, where the higher number represents the greatest weakness. I am aware that my port is somewhat higher than those in use, but inasmuch as I do not cut into, or interfere with, the main deck or upper deck beams, I do not in any way weaken the vertical strength of the ship.

Such, then, is the port I originally pierce in the side of the ship, and I have travelled rather out of my way to show that in doing this, I do not cause any local weakness, but the opposite! Within this port I place what I call a "broadside turret!" This turret is of a cylindrical shape, with a spherical head, and has its inner part cut away so as to be quite open to the fighting deck, but externally is a perfect turret. (See Plate III). Like a central cupola on Captain Coles' plan, this broadside turret revolves upon a pivot in its centre, carrying the gun with it, to the extent of lateral training which it is possible to obtain. The gun-slide and the base of the turret are in one piece, or, as it would be in practice, the slide would be firmly attached to the lower part of the turret, so that when the turret moves, the gun moves.

Both turret and gun are set in motion (for training purposes) by a winch, acting at the rear end of the gun-slide, where a raised framework of iron, less than the height of the gun at the breech, and protected from shot by the gun itself, would contain all the needful machinery both for training and running the gun in and out, which would simply be a winch fitted with multiplying power, and capable of being thrown out of gear as required.

The turret, gun, and slide may be considered as one machine, viz., as a lever of the second order, with the power acting at a considerable distance from the weight. The leverage would be so great, when the gun was run out for firing, that the *power* required for moving the machine (in other words for training the gun) would be exceedingly small, so small, that with the assistance of a winch, the strength of one man would amply suffice for the purpose.

The weight of the gun and turret (about 20 tons) would be almost

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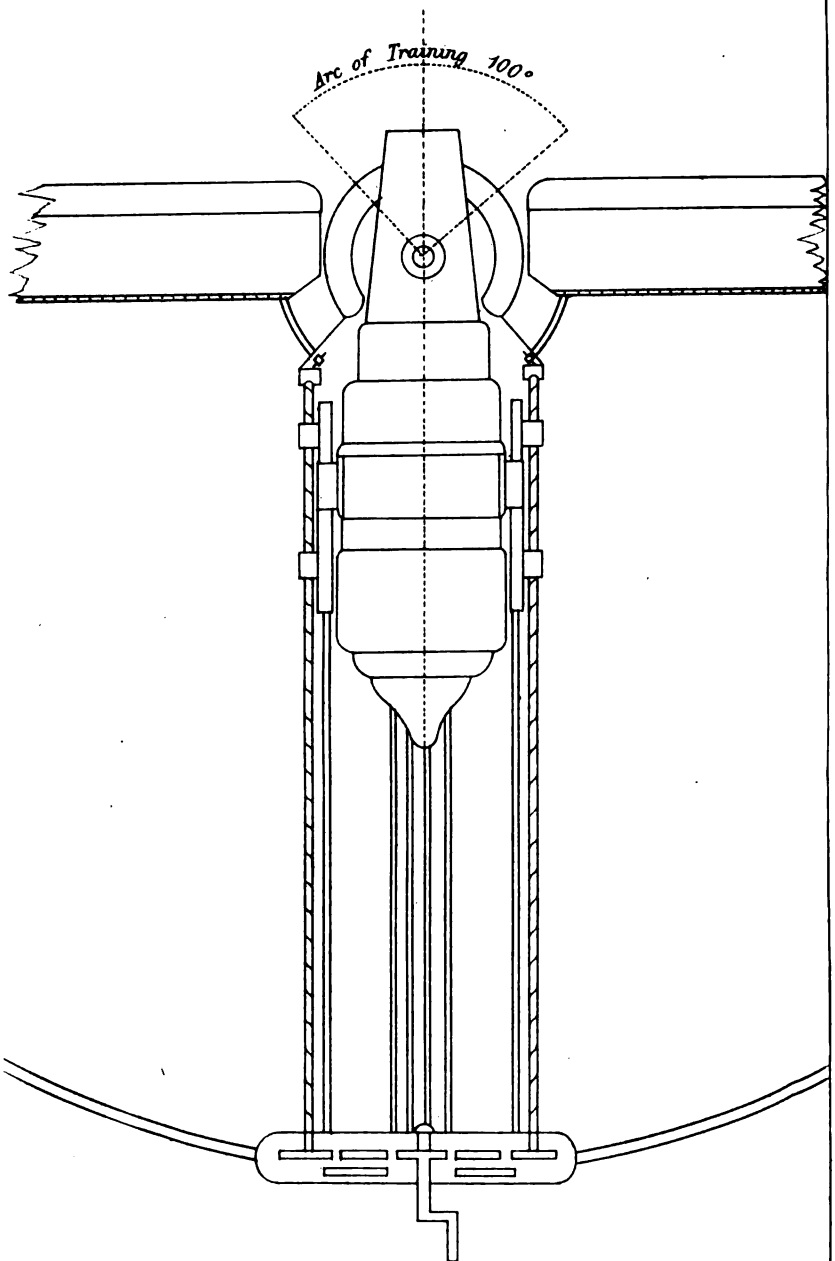

Deck Plan.

Scale ¼ Inch to a Foot

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entirely borne by the pivot, except when the gun was run in for loading, when of course the wheels of the gun-slide would take their share of the weight.

Accordingly I provide a hollow cylindrical pivot of about a foot in diameter from outside to outside, made of 4-inch iron; just such a pivot as Captain Coles uses for bearing the weight of his central cupolas, only about a third of the size, the weight to be carried not being much more than a tenth part of a central cupola with its guns. This pivot is perfectly protected from shot or accident by the lower part of the turret, and by the adjacent armour plates, so that it is almost impossible that the pivot could be damaged; for even if it were to be struck by a shot which had succeeded in penetrating the ship's side, it could hardly receive any injury. At all events the pivot I propose, and the protection I give it, is greatly superior to any pivot yet devised for working broadside guns.

The turret I employ is very small, being only 6 feet high, 4 feet in diameter over all, and 6 inches thick, and exactly fitting into the original port pierced in the ship's side, only leaving sufficient room for it to work. The turret itself is pierced just enough to admit the muzzle of a 12-ton gun, and to allow of its elevation and depression some 7° or 8°. The consequence is that the exposed port is so small (3 feet high and 1 foot 8 inches* wide) that the greatest possible amount of protection is given to the crew of the gun. It is useless to say, as some Naval Officer said on a former occasion, "we do not "want our men protected," for the country insists upon having its men protected. Moreover, the greatest fire-eater will allow that he wants his gun and its carriage and the needful apparatus for working it protected, for if this precaution be neglected, all the bravery in the world cannot save the capture of a ship whose *guns* are disabled.

It will, therefore, be quite plain that my port, which has only an exposed area of 4·233 square feet, gives a much greater amount of protection for crew, gun, and its apparatus, than that afforded by the present ports fitted to the latest broadside ships, which have an exposed area of 9 square feet.

But, it may be said, you may purchase protection at too dear a price. To this I reply, that so far from this being the case, I actually obtain it without paying so much for it, as is paid by the existing ports for the small amount of protection they obtain. The elevation and depression would be about the same in both cases, but as regards the lateral training of the guns there is no comparison.

The existing style of port with its 9 square feet of exposed area barely affords 30° of training, making a total arc of training of 60°. My port, which I have shown does not weaken the side of the ship so much as an ordinary port, and which leaves only 4 square feet exposed for the admission of shot, nevertheless provides for the lateral training of the gun to the extent of 50° each way, making a

* Since the delivery of this lecture I have found that I must allow a few more inches in the width of the port, to allow of the aim being taken along the side of the gun.—A.A.W.D.

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total arc of training of 100°, or about two-thirds as much again as the existing amount.

It is the easiest thing in the world to provide for a great amount of training, so long as you increase the size of the port; but in this plan, which I submit to you, I get the maximum of training, with the minimum size of port, both as regards the weakening of the ship and also the exposed area; consequently I sacrifice nothing at all in order to obtain protection, but on the contrary I gain in every respect. Two years ago I was told here that it was a matter of no great consequence, whether broadside guns were capable of great lateral training or not, as the double screw principle would speedily enable them to be trained everywhere. To this I demur, as I did then, as it is not fair in a *comparison of plans* to imagine the exponent of one plan as having double screws and the other not. If my plan be compared to the existing plan, then if the ship representing the latter has double screws, the former must also be supposed to have them, when I shall show that I still have the advantage.

But in point of fact, it is a very doubtful point whether in extremely long ships, like the "Agincourt" or "Warrior," the double screw principle would enable them to turn with sufficient rapidity to be of any service in working their guns, while at any rate, that ship which could train her guns through the largest arc, would require the least assistance from her screws, and therefore would be so much the more serviceable ship of the two.

Again, in any ship, whether short or long, the screws may be injured, or the engines disabled, and if this were the case in two ships engaging each other, then would come in the value of great lateral training of guns. The same advantage would hold good in the case of a ship attacking a fort, or choosing a position for attacking a vessel, in either of which cases the power of training broadside guns through an arc of 100°, instead of 60°, might very easily make all the difference between victory and defeat. This, by the way, is where the turret-ship proper is seen to its greatest advantage, by reason of the very large amount of training which all her guns have. My plan is to bring the broadside-ship as near the turret-ship, in point of training, as it can possibly be brought.

A recent experiment, made at Shoeburyness, has enabled me to show the great value which is to be attached to my method of working 12-ton 300-prs. on the broadside, so as to gain an additional 40° to the arc of training.

The experiment was that of firing at an improved "Warrior" target placed at an obliquity of 30° from a right angle, or in other words at the extreme angle of training possible to be obtained by any existing broadside-ship for all her guns.

The result of this experiment was, that the target was penetrated by a Palliser shot fired from the 7-inch Woolwich gun, the weight of which gun is only 6½ tons.

Suppose, for an instant, that the target had been the actual "Warrior," and the gun had been fired from an enemy's battery. The "Warrior" could not have decreased the angle of obliquity her

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sides made with the line of fire, without doing away with the possibility of answering the battery with her own guns. But suppose that the "Warrior" were fitted with my ports, and with 12-ton guns, she could then, with a slight touch of the helm, decrease the angle at which her sides were inclined to the line of fire, from 60° to 40°, and still be able to answer the battery with all her guns, and it remains to be proved that, at an angle of 40°, her sides could be penetrated by any gun in existence, notwithstanding the penetration of the improved "Warrior" target at an angle of 60°.

The least that can be said for my plan of providing a great increase of lateral training is, that I have all the chance on my side that no penetration would be possible when my guns were extreme trained, whereas the contrary has now been *proved* to be the case as regards the existing broadside-ships.

I do not know that anything further need be said about my method of *training* broadside-guns, in order to make it intelligible, except that in place of the ordinary kind of rollers, I should substitute flanged wheels for the gun-slide and also for the gun-carriage, so as to give steadiness.

The pattern would be something like a railway carriage-wheel, the size, that of the ordinary roller in use, except those at the rear end of the slide, which would be somewhat larger, and to these would be fitted a lever break, so that the training of the gun could be checked at any required point, and the gun fired without any chance of the slide shifting and thereby diverting the aim.

I still advocate the use of iron for everything connected with the gun and its carriage. Along the slide I would fit iron ways on which the wheels of the gun-carriage would rest and run with the least possible amount of friction, so as to facilitate the operation of running the gun in and out.

The best method of taking up the recoil of the gun, is I think, that employed in the compressors fitted to the competitive carriages of Sir William Armstrong and Captain Scott on board the "Bellerophon," both of which compressors, I am informed, work extremely well and are the inventions of the above-named gentlemen.

Before I pass away altogether from the subject of *training* guns, I wish to point out another advantage which my plan secures. It is that of closing the open port while the gun is loading, by turning it away from the point of firing.

In the ordinary broadside-ship, when the gun is fired and recoils, it leaves the whole of the port open, and until the gun is reloaded and run out again, the crew of the gun are completely exposed, whereas with my ports the fire of the gun is delivered, when a few turns of the training-winch causes the small open port there is to disappear entirely; and it must be remembered that if two ships are pretty nearly matched in speed, size, weight, and number of guns, that ship will eventually win the fight which has the greatest number of men left uninjured. A few well-directed shells exploding through open ports would soon reduce a ship's company to nothing, at which

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point it is a matter of no consequence that the vessel has a number of splendid guns, if she has not the men left alive to work them.

I now come to the subject of running heavy guns in and out. On this point it has struck me that the present plan of using an endless chain passing over rollers, is singularly ill adapted to do the work required of it. Moreover, I cannot see how it can possibly be expected to work in a heavy sea-way.

I have, therefore, devised a plan of running guns in and out, which plan I think will give perfect control over the heaviest gun, in the heaviest sea, and with the ship pitching and rolling to any extent.

In the recent cruize of the iron-clad ships of the Channel Fleet, the much-vaunted "Bellerophon" was utterly unable to fire her guns when she was only rolling some 18°, and this, partly on account of her large open ports admitting so much water, and partly on account of the impossibility of running the guns out with the endless chain, which having a certain amount of slack, threatened at every lurch the ship gave, to allow the gun to "take charge."

A ship fitted with my plans would be open to neither of these objections; first, on account of the extremely small open port, and next on account of the firm hold and the perfect control which my apparatus would give over the gun in every conceivable position. Indeed so long as the muzzle of the gun did not actually enter the water at each roll, I would undertake, by a small addition to my port, to continue the accurate firing of the guns, when the "Bellerophon" would be making for the English shore; and if engaged with her in very rough weather, to sink her when she could not open a single port to return my fire.

Instead of an endless chain, I propose an endless screw, which will be seen at a glance (Plate IV) to afford a perfectly vice-like grip, so that the gun may, by the inexorable compulsion of mechanical force, be made to go out or in, with the utmost certainty and at the same uniform pace, no matter how much the ship is pitching and rolling about.

I provide two screws the length of the gun slide, one to be fixed on each side of the gun-carriage. These screws would be right- and left-handed, with a rather coarse, flat thread, and would be pivoted at both ends; at the rear end of the gun, in the raised framework which contains the training-winch, and the other end in a smaller framework attached to the slide. The screws would be set in motion by the same winch which trains the gun, the machinery being thrown out of gear for the one purpose and into gear for the other. The screws would work through boxes, fixed to the sides of the carriage, containing the matrix of the screws; and lest the rapidity of the recoil of the gun should endanger the stripping off the thread of the screws the boxes would be made in two pieces, so that by a hinge-like process the screws would be altogether disconnected from the gun while it was in the act of being fired. In Plate I, I have placed the screws rather high up, and for this reason, they are protected by the turret from injury by shot, and the fact of their being in the position shown will secure great steadiness for the gun when the ship is pitching. They might

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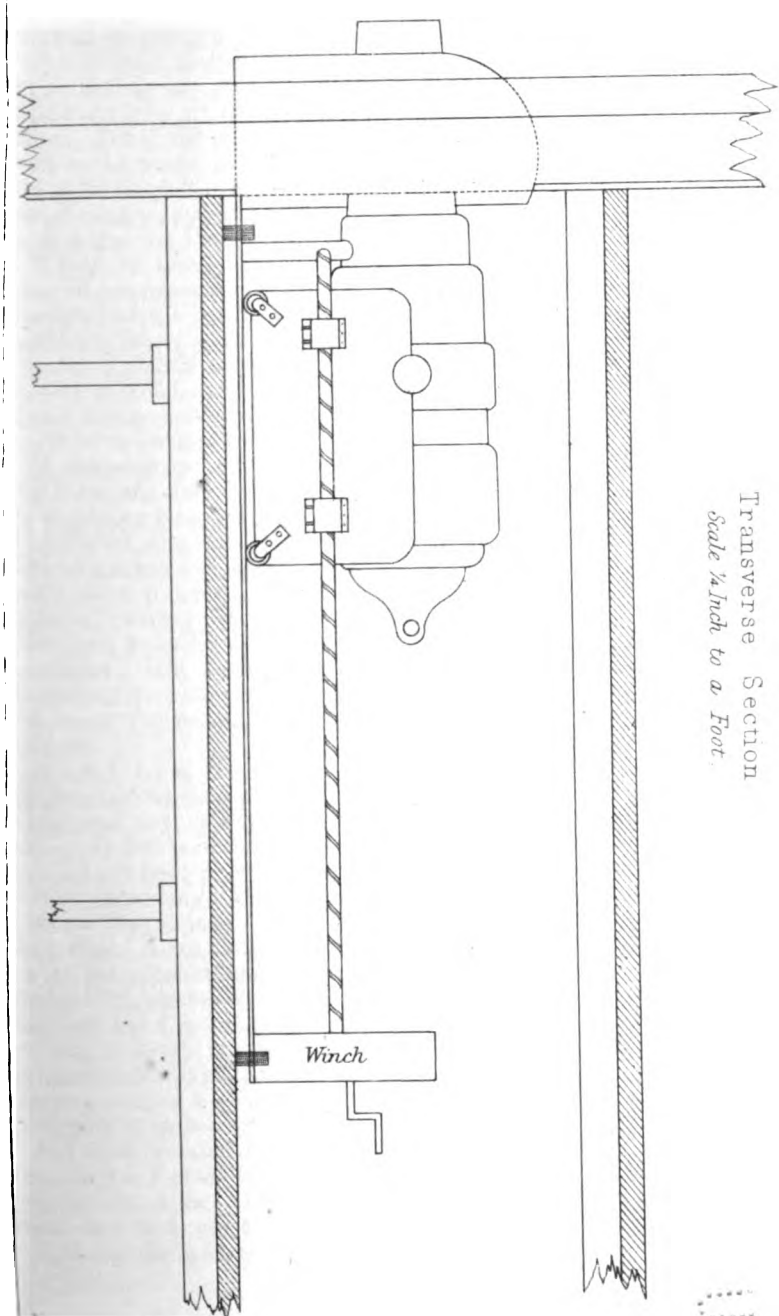

Transverse Section
Scale ¼ Inch to a Foot.

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however as easily be placed lower down, and I may be told "that in "their present position, they would be decidedly in the way of the "men loading the gun;" but this is not so, as there would be sufficient room for a man to pass between the end of the screw and the turret. But if the position of the screws at the sides of the carriage were to be found inconvenient, one single screw would suffice, and this might be placed in the middle of the slide, just clear of the under part of the gun, and still as before the same winch would do the double work of training the gun and running it in and out.

It may be thought that although the screw is a very powerful piece of mechanism, it is slow in its action, and so it is by itself; but connected with a winch with multiplying power, the screws I propose would not have the disadvantage of being slow in their action; on the contrary, I should anticipate that with the above named machinery, a 12-ton gun could, even in smooth water, be run out and in more quickly than is now possible with an endless chain, while in a heavy sea there would be no comparison whatever.

In summing up the description of these plans I claim and can prove that I was the first to suggest the training of heavy broadside guns by machinery placed at the rear end of the gun-slide; indeed when I introduced that idea two years ago in this room, no such plan had been adopted in the Navy; but long before that I had made it known, and I have in my possession a letter from the present "Chief Constructor," bearing date September, 1863, and another from the present First Lord, in both which letters my plan is referred to. I have also a tradesman's bill, dated July, 1862, for the construction of a model illustrating the whole of these ideas of mine, except that of the endless screw for running guns in and out, which I have only lately devised.

And now I will bring this paper to its conclusion, with an apology for its rambling character, only observing that being the incumbent of a large and poor suburban district, and having for many weeks past had nearly 500 poor families in utter destitution, and looking to me for help, I have been prevented by almost incessant work, night and day, from devoting any time to its more careful preparation and revisal, for with me these things are matters of amusement and recreation rather than work. I am quite sure therefore that this paper must be full of verbal inaccuracies and errors of construction, but I trust you will pardon all these faults when you know the cause of my hurry. Having promised some months ago to prepare and read a paper upon the working of heavy broadside guns, and being set down in your printed programme to do so, I have endeavoured, as best I could, to keep my promise, though I have been obliged to snatch my time for doing it principally after twelve o'clock at night.

If I have omitted any material point, or have not made my ideas clear to you, I shall be very happy to answer any questions you may desire to put to me. I thank you much for the attention you have given me, both on the present, and also on the former occasion when I had the honour of appearing before you.

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The CHAIRMAN: We thank Mr. Drew for the paper which he has just read to us. It displays great ability, and I hope some of the gentlemen present will give their opinions respecting it.

Commander DAWSON: I think we must all be pleased with this paper which is excessively clear, and which Mr. Drew has taken the pains to come forward and read. I rise rather for the purpose of eliciting more information, than for the purpose of finding fault. It appears to me that, by cutting away the bottom of the turret and reducing the waste part, you would not cut away so much of the ship's side. By cutting away the ship's side only one half that height, you might do away with what appears to me to be the waste part of the turret.

Mr. DREW: The lower part, that would place the muzzle of the gun so near the water?

Commander DAWSON: I mean, keep the gun the same height, but cut away the turret, and replace the ship's side up to the gun, so that your port instead of being the present height, would be half the height. But the gun would be the same height from the water, only you would reduce the lower part of the turret.

Mr. DREW: I should have done that, but I was unable to devise a good scheme for connecting the turret with the gun slide.

Commander DAWSON: I am not very clear, as a second point, how the salt water is to be kept out. It appears to me that the water would come in all round the turret; that is, between the turret and the ship's side, and of course through the port itself, unless you had some means of stopping it. I dare say you have means, but it does not appear very clear how you are to keep the water out.

Mr. DREW: I have devised a scheme for that, a circular boiler plate, for sea-going purposes fixed over the exterior of the port, and up to the level of the lower part of the gun, and another part to fit down over it, to be removed in actual warfare.

Commander DAWSON: That is very satisfactory; still, in the supposed case you gave us of the "Bellerophon" in a gale of wind, with a sea coming in, where we have a plan—certainly a very rough plan, I cannot say altogether a very feasible one—in which we can lower the ports and fire between the seas, it appears to me you could not adopt a plan of that kind with your turret, because the water must come in round the turret very largely indeed, particularly if you bring the port so much nearer to the water line than it is in the old port. That you could remedy, by reducing the lower part of the turret by cutting it away, and bringing the ship's side so much higher, you would thus do away with that objection to the turret.

Mr. DREW: The fact is, that the model at which you are looking, has been in the Institution since my last lecture, in 1865, and I have not had the opportunity of adding that to it which arose out of the discussion last time. I had thought previously of that plan, which would at all events bring the lower part of the port-sill higher up than in the "Bellerophon." I should propose to fit that circular boiler plate as a permanency for the purpose of keeping the sea out; and in a gale of wind I should drop down the other part over it.

Commander DAWSON: Now, with reference to the carriage, yours seems a very ingenious and simple arrangement for running in and out, and training the gun. You disconnect the screw from the carriage when the gun is fired, which gets rid of the first difficulty suggested to my mind. One is not perhaps enough accustomed to these guns to speak with certainty, but it seems to me that if a shot were to knock away the machinery, it would be difficult to repair such damage. You might get over it by the use of tackles. It seems to me that this traversing gear is not very different from that first used by Sir William Armstrong some years ago. He brought it out for breech-loading guns some five or six years ago. I do not see any other objection to that part of the invention, which appears very nicely got up.

Vice-Admiral CODRINGTON, C.B.: Is the screw entirely liberated from the carriage when the gun is fired?

Mr. DREW: Entirely.

Admiral CODRINGTON: Because if not entirely liberated, it is as bad as if not liberated at all. There is another point I would remark upon. I think you have not contemplated the jambing of your turret by a shot. The gun would, I think, be more likely to be disabled from jambing in your turret than in the present turret. I think you mentioned that you keep the side of the port square?

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Mr. DREW: Yes; the edge of the port.

Admiral CODRINGTON: But suppose you were to extreme train to an angle of 50° one way, marked by the red lines on your diagram, and then to extreme train the other way, also marked by red lines, all that is not occupied by the red lines might be filled up by the strength of the ship, thereby reducing the port still more.

Mr. DREW: The line shows the centre of the gun. The gun will almost touch the edge of the port, and there is no room left. You see that the gun is made almost to touch the port.

Admiral CODRINGTON: But if you train the other way there is an angular space. It was an argument many years ago that in all our old ships that piece ought to be filled up with timber, and in the present day it might just as well be filled up. So, I think you might modify your plan of having it square, by simply taking what you want for the position of the gun, extreme train one way, then extreme train the other way, and then you will find a vacant angle on each cheek of the port, which you might just as well fill up by strengthening the ship's side.

Mr. DREW: That would certainly strengthen the port, and reduce it. The case of jambing I had thought of, and provided against. The working of the gun could not be stopped by jambing, unless both sides were jambed at once, which is extremely unlikely to happen. The leverage is so great that I have simply to heave round the winch in order to drive out a wedge or other obstruction.

Admiral CODRINGTON: As to that, it seems to me that the whole of the motive power will depend upon one winch, and I should be very glad to have reserve tackles to fall back upon.

Mr. DREW: The length of the slide is about sixteen feet. The weight of the whole apparatus is thrown almost immediately over the pivot; and it being a lever of the second order, the power acting at a great distance from the weight, the power required for training will be extremely small. In fact, in practice, I should not wonder if you could push it along.

Admiral CODRINGTON: I am not speaking of the power, but suppose the winch were carried away.

Mr. DREW: If the winch were carried away, you could push it along. At all events, temporary training tackles would do it.

Admiral CODRINGTON: You propose a slide and pulley.

Mr. DREW: Yes.

The CHAIRMAN: We are all very much obliged to you for having brought this subject forward. I cannot but believe that in so doing you have been doing public service, and I hope it will receive that attention which it deserves.

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LECTURE.

Friday, February 15th, 1867.

MAJOR-GENERAL SIR FREDERIC ABBOTT, C.B., Member of Council of Education, in the Chair.

A NEW METHOD OF IMPROVING THE MEMORY AND FACILITATING THE ACQUIREMENT OF KNOWLEDGE.

By Dr. EDWARD PICK.

I HAVE been occupied for some years in this country in teaching a method of improving the memory, or rather of facilitating the acquirement of knowledge. This method is based upon a principle different from that generally admitted. The fact is, we think that it depends upon the memory, if remembrance is easy or difficult. Now, I think that memory has very little to do with the facility or difficulty of remembrance. This may seem paradoxical; at any rate it will be a consolation for those, who have bad memories. But I think I have only to draw your attention to our daily experience to show you how little memory has to do with the facility or difficulty with which we remember. Not those things which we committed to memory are the easiest to be remembered. There are things which we saw, or heard, or experienced, once in our lives, and which we never forget, whereas things which we have committed to memory, very soon pass out of remembrance. You will hear old people say that they recollect things of their youth, sometimes 60, 70, or 80 years ago, and that they are not able to recollect things of yesterday. This is another proof that memory has nothing to do with it. Because if it were loss of memory with old people, it ought to be much easier to recollect recent things than very remote ones, but just the contrary takes place. We endeavour sometimes to recall certain ideas to the mind, and notwithstanding all our efforts we are not able to do it, and we find, that those same ideas later, come suddenly back, without our co-operation, even sometimes against our will. All this would be impossible if memory had anything to do with it. If I have a good memory for proper names, for instance, I ought to be able to remember a name whenever I want to do so, but there is no reason why I should not be able to recall to my mind a certain name, otherwise quite familiar to

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me, and why that same name later suddenly should come back, without my co-operation and even against my will. The reason of all this is, that memory is the faculty of the mind to recall, or rather to have back, ideas, which were there once before, but the facility or difficulty with which the ideas come back, depends entirely upon a simple process, going on in our minds not when we remember, but when the ideas first come to the mind. This process is no new discovery, the great Aristotle has already fixed the laws of the reproduction of ideas. Nevertheless this law, which is a very simple one, has been practically overlooked, just because of its simplicity, and we have done and do our best to oppose it, and consequently to impede, instead of aiding the natural functions of the mind. I shall endeavour to explain the law by which we remember, and to show that in paying attention to the very simple reasons why we remember certain things, whereas we forget others, we are able to strengthen our memories to an almost incredible degree, without applying those cumbersome artificial means, or so called mnemonics, which present means more difficult to overcome, than the things they aim at mastering.

Before I explain the theory, and show its applications, I will venture to lay before you some of the results, which can be obtained with it. And in order to show as much as possible in one instance, I shall choose numbers, because numbers are always regarded as the most difficult to be retained. You know how little hold they present to the mind. I will therefore show at once, with what facility even larger numbers can be impressed on the mind. The easiest way to read a number of 60 or 80 units, is to divide them at their proper periods of thousands, millions, billions, and so on. We will group together a number of units, taking always three at the time.

[The lecturer marked off a black board into 25 compartments which he numbered and then continued:]

In inscribing three units in each of those compartments, we will be able to group together 75 units; and in order to show you that the difficulty is not very great, we will not fill up those compartments in their regular sequence, but quite at random. Be so good to mention always three units at the time and indicate the compartment in which they are to be inscribed.

[The following figures were then given by the audience and written down on the board by the Secretary:—

111, 298. 456, 756, 749, 540, 359, 634, 958, 972, 861, 846, 531, 167, 384, 284, 786, 296, 980, 157, 536, 573, 715, 762, 873.

The lecturer then repeated the figures from the first to the last, and then backwards, and afterwards indiscriminately, the number of the compartment being given, he named the figures inscribed in it and *vice versâ*.]

After this he continued:

I could extend those tests to proper names, words, phrases, and so on. But as my intention is not to show feats of memory, but rather to explain how memory can be improved, instead of continuing those exercises, I will now proceed to explain my theory.

We know by experience that those things, which make a strong im-

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pression agreeable or disagreeable, are always easily remembered, whereas indifferent things, or such as we have paid but little attention to, pass out of remembrance, in other words we find that those ideas, which came to the mind with a great strength, always come back easily.

I need not say, that the things we see, we hear, or read, &c., are all ideas coming to the mind. We know by experience, that if ideas come to the mind, they generally find other ideas present, but they usually expel those they find there, and also recall others. So, *e.g.*, if I now succeed in fixing your attention to what I say, all other ideas will disappear from your minds for the moment. This is generally but not always the case. Sometimes the ideas which were present before, do not disappear. The fact is, that like in the physical world, where the stronger beats the weaker, you will find, that stronger ideas always beat weaker ones. If those ideas, which come to the mind are stronger than those they find present, they will make use of their strength and expel the weaker ones. This is shown in the fact, that if one thing attracts our attention, all other ideas disappear from our minds for the moment. But if the ideas which try to come to the mind find others present which are stronger, then those latter ones make use of their strength and do not admit the new comers, they repel them immediately. This is shown in the fact, that if something preoccupies us, we neither see nor hear what is going on around us, though we are in the same physical condition, as we were before. Our eyes and ears are open, but the ideas trying to come in through those channels are repelled by the strong ideas present in the mind. A very striking proof of this action and reaction (as it is called) of ideas in the mind, is of daily experience. You are sometimes occupied with something which absorbs all your attention. Say, for instance, you read a book, which you like very much, there may be other people in the same room talking, or even playing music, but you neither see nor hear anything because the book absorbs your attention. But sometimes you suddenly stop, because you have just observed that you do not know what you have been reading about in the last ten or twenty lines, and you must read it again to know what it is. This will happen if chance brings to the mind an idea, which is stronger than those coming from the book. As long as the book fixed your attention, nothing else was admitted. But a word spoken, a noise heard, or even sometimes an idea recalled to the mind by the book itself "crosses the mind," in other words, an idea appears which is stronger than those coming from the book. From that moment nothing else is admitted, and this is why you do not know what you have been reading about in the last ten or twenty lines.

If two ideas are in the mind of which one is stronger than the other, the stronger one will expel the weaker one. But suppose two ideas of equal strength in the mind, what will be the result? Again, like in the physical world, if the two ideas cannot fight each other, they will shake hands, that is to say, as one cannot expel the other, they will blend together. This blending of ideas, which is constantly going on in our minds, is not only the basis of remembrance, but of all intellec-

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tual activity! Because we know by experience, that those ideas which blended together in our minds, if, later, one of them comes back, or if we recall it, it will recall the other with which it blended, and this recalling of one idea through another is remembrance or recollection, for, with the slightest attention you will find, that an idea never comes back to the mind by itself, but is always recalled by another. The facility or difficulty, with which one idea recalls another, depends upon the strength with which they blended together. If there was a strong blending, there will be an easy recollection, if there was a weak blending, there will be a difficult recollection, if there was no blending, there will be no recollection.

The strength of the blending depends upon the intrinsic strength of the ideas. Strong ideas will blend strongly together.

This theory explains all the phenomena cited above, in connection with memory. We do not forget certain things, though seen, or heard, or experienced only once, because when they happened, they made a very strong impression, in other words, they came with a great strength to the mind, and blended strongly with other ideas. This is why they come back easily. Old people recollect things of their youth, because those things made a strong impression when they first came to the mind, blended strongly with other ideas, and consequently are always easily recalled.

We have nothing to do with those blendings, they are going on in our minds without our co-operation. The proof that it is so, is the fact, that we cannot forget things which we would like to forget; those things when they happened made a strong impression, we did not like the impression, but we could not help it.

As the facility or difficulty of remembrance depends upon the strength with which ideas blend in the mind, the only means to strengthen the memory or rather to facilitate remembrance, is not to deal with memory at all, but to find means to strengthen ideas which are too weak to make an impression. I have not to offer you new means which I have discovered, or very complicated means to strengthen impressions, on the contrary, I apply very old and very simple means, which everybody applies more or less. But I venture to say, I shall show you some new results, which you will obtain with very old and very simple means. I need not say, that these means are taken from experience. We know by experience, that if there are too many ideas at the same time in the mind, they weaken each other. If we try to think of too many things at once, we forget everything again in a very short time. The first means therefore I recommend to facilitate remembrance, is to concentrate our attention to as few ideas as possible at the same time, because, the fewer ideas there are at the same time in the mind, the stronger they will be, and consequently the stronger the blending.

Another very simple means to compel our attention, because this is all, is *comparison*. Because if I compare two things, I am compelled to pay equal and exclusive attention to the two things which I compare. The trouble I take to seek their connection strengthens them in my mind, and consequently they will blend strongly together.

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If later one of them comes back to the mind, or I recall it, it will recall the other with which I compared it. These recollections are so easy, that, as you know, not only things which we compared, but even things which we never compared, but which bear a great resemblance, or a great analogy, recall each other.

These are the two simple means—I may say the two exclusive means—which I endeavour to show, we can apply to whatever we have to learn by heart, or to keep in mind, viz., first; to concentrate our attention to as few ideas as possible at the time, and secondly; to compare.

If I say compare, there is sometimes no necessity for comparison: I mean in such cases where the connection is obvious. Take for instance two ideas, like book and printing. There, is of course, not the slightest necessity to seek the connection of those two ideas. In such a case it is quite sufficient to concentrate our attention for one moment only, so that they may blend strongly in our minds. Usually we are recommended to associate ideas, that is to say to combine them to a picture or an arbitrary connection, *e.g.*, you would say a book printed, &c. But you will find, that if we associate ideas, we spoil the *real* association, that is to say, the blending going on in our minds without our co-operation, which I endeavoured to explain before. I will show how strong those associations are if we do not meddle with them, if you will allow me to give you a series of ideas. I shall always mention two ideas at the same time, their connection will be obvious; you will therefore kindly pay one moment's attention only to the two I name together, but you will please in going on, never to pay any more attention to the preceding ones. Dismiss them entirely from your mind.

The lecturer then named the following ideas:—Book—printing, printing—newspaper, newspaper—telegraph, telegraph—Atlantic cable, cable—America, America—cotton, cotton—Manchester, Manchester—Sir Robert Peel, Sir Robert Peel—free trade, free trade—navigation, navigation—Australia, Australia—gold, gold—jewelry, jewelry—fine arts, fine arts—picture gallery, picture gallery—Trafalgar-square, Trafalgar-square—lions, lions—zoological gardens, zoological gardens—animals, animals—hunting, hunting—breech-loaders, breech-loaders—needle-gun, needle-gun—Prussia, Prussia—Rhine, Rhine—wine, &c.

If you have concentrated your attention always to the ideas only I named together, there were always two ideas only at the same time in your minds, the connection was obvious, consequently they were very strong, and blended strongly together; that is to say, the first blended with the second, the second with the third, and so on, and the proof that they so blended, is that if I now give you again the first, or if you recall the first, it will immediately recall the second; the second coming back, will recall the third, the third the fourth, and so on. The first recalling the second only, and so on, none will fail. More than this, you will find that not only the first will recall the second, and so on, but one of them taken at random will recall all the others. If, *e.g.*, you take the last, that last will recall the one before, because it

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blended with it; this again the one before, and so on; so you will recall them backwards with the same facility as forwards.

[The experiment was made by the audience, and succeeded completely.]

Another advantage of that simple means to pay attention to two only at the time, is that the difficulty does not increase with the number, as we never have to pay attention but to two, notwithstanding the number.

This can be applied each time we have a series of words to learn by heart. If a series of isolated words is to be kept in mind, the task can be accomplished in different ways. In some cases it is necessary to know a series of words in precisely the same order in which they are given; in other cases the order of the words is of no importance. In cases of the latter kind we can arrange the words ourselves, so as to take always two together, which we can easily compare. We are thus able to make of it a series of connected ideas, like the above given. If we have such a series, one perusal will be sufficient to impress it on the mind, if we never pay attention but to two. In neither looking backwards nor forwards the difficulty never increases with the number. I found that this way of arranging isolated words is of great assistance in such cases as in grammars, where we have exceptions to learn, for I found that this method of learning them teaches us at once not only the exception, but the rule too. If you allow me, I will give you a practical instance. The words I just gave were the first words I found, in which I was sure you would see a connection; but I will now give you a series of words, which most of us had to learn in school, and which I am sure we have mostly forgotten again. I will first give the words, and afterwards tell you what they are. You will please again to pay attention to two only at the time, which I name together:—Mullet—fish, fish—river, river—channel, channel—ditch, ditch—worm, worm—dust, dust—footpath, footpath—hillock, hillock—stone, stone—fire (because of flint), fire—firebrand, firebrand—bellows, bellows—ashes, ashes—fine flour, fine flour—bread, bread—cucumber, cucumber—stem, stem—thorn, thorn—bundle, bundle—club, club—lever, lever—axletree, axletree—ploughshare, ploughshare (emblem of peace)—sword (emblem of war), sword (artificial weapon)—nail (natural weapon), nail—blood, blood—snake, snake—dormouse, dormouse—net, net—hair, hair—rope, rope—collar, collar—circle, circle (orbis)—month, month (division of time)—end, end—door-post.

[The audience then repeated the whole list with the greatest facility and precision.]

These words are a series of exceptions, which we had to learn in the Latin grammar. You remember the rule, that all nouns of the third declension in *is* are feminine, with the exception of about 36 or 37 words.

The words I just gave are those exceptions. You remember the trouble we had, and the time it took, to learn those words, and even after having learned them well, we soon forget many of them; at any rate, if one of those words occurs, we are not always sure if it is an exception or not. But with my method it is just the contrary. Not

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only it takes no time, it requires no effort to impress such a series on our minds; but you will find that if we take the trouble to go through such a series once or twice more, they will be indelibly impressed on the mind. For if afterwards we want to know whether a word is an exception or not, we have not to go through the list, but the word itself tells us if it is an exception, as each of those words recalls the preceding and following one, and is therefore immediately recognised as belonging to the series. I am sure it does not take you one moment's reflexion to tell me if the words *sword*, *fish*, *end*, *net*, &c., were in the list. If, therefore, I find that the word is a word in is, ensis, piscis, finis, cassis, I directly recognise it as an exception. More than this, if a word occurs which is no exception, the word itself tells me that it is regular, because it does not recall others of the list, is therefore not in the series of exceptions. I found that this method of arranging exceptions, enables students of the French language to know the genders of French nouns with great precision and certainty.*

I gave the English equivalents of the Latin words, because I had to do with the idea the word expresses. If we know the Latin word, it is of course quite indifferent if I say mugilis or mullet, piscis or fish, &c.; but if we do not know the Latin words, they cease to be an idea. It requires, of course, some more time, generally five more lectures, to show all the applications of the principles which I have the pleasure to lay before you to-day; then I show, of course, how to apply it to foreign languages. But to-day I may be allowed to add a few observations only about some other practical applications of my method. My principal means to facilitate the acquirement of knowledge is, as you have seen, comparison. But in comparing, it is most essential to take *the known* as a basis of comparison for *the unknown;* whereas, usually, we do the contrary. I tried to apply this principle, *to go from the known to the unknown*, to the study of foreign languages, and I will here explain the fundamental idea which I have fully developed in my books "on Memory" for the German, and "on language" for the French.

The general way adopted for the study of a language is to begin with the alphabet, the reading, and the grammar; that is to say, to learn unknown details, unknown particulars of a thing equally unknown; whereas the easy and natural way would be, to start from known things, and to compare the unknown with it, as far as possible. I have for many years practised the application of this principle, and have obtained astonishing results. I give first those elements of the foreign languages which are to be found in our own language; the unaltered ones first, then the altered. In pursuing the laws by which the different languages have been formed out of others, and are progressing still, it is very easy to give to the pupils a great number of elements, not only of words, but of whole sentences, &c., which would be identical with or analogous to the words and phrases of his own language. Thus the pupil is introduced, in a very easy way, directly into the very life of the language he intends to learn, without any

* See Dr. Pick: A New Method of Studying French. Trübner and Co.

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mechanical labour of the mind, more by comparing and reasoning. He soon gets accustomed to the changes the same roots undergo in analogous languages; and having in this way learned a small piece of prose by heart, he will find in this piece a great number of the rules of the grammar applied, consequently known to him without having been aware of it. So he goes always from the known to the unknown by comparison and reflection, and he very soon becomes master of the foreign language, without much trouble, and in a surer way than the usual one, because the association of analogous ideas, which is always going on, assures their reproduction for the future.

I have also tried to apply those principles to the teaching of writing and reading. If, instead of beginning with the letters, you begin with something known, you will see how soon the pupil becomes interested in the subject, and, consequently, how quick his progress will be. Anything the pupil knows by heart, is *the known* to begin with. Your Military Authorities gave me an opportunity to try this method with some soldiers of the Guards. As I supposed that they knew the Lord's Prayer, I took this as *the known* to start from. The pupil knows by heart the words, "Our Father, which art in heaven." If, therefore, I show him those words printed, or on the black board, and tell him the first word is "our," the second "Father," and so on, he will repeat them at once. I take then each word separately, show in different places and amongst other words, until the pupil recognizes some, and, by-and-bye, all. I give him a slate and tell him to imitate the word on the slate, which he very soon accomplishes. He first learns the whole word, and then the details. So he learns reading, writing, and spelling at the same time, and one assists the other. I had the soldiers, about 15 to 18 men, 30—40 times, about an hour each time. Unfortunately, they had to leave London for Aldershot, and I was unable to continue; but I am convinced that it would not have taken more than another 30 or 40 hours to enable them to read and to write fluently and correctly.

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LECTURE.

Friday, March 1st, 1867.

LIEUTENANT-GENERAL SIR GEORGE ST. P. LAWRENCE, K.C.S.I., C.B., in the Chair.

"THE SIKH AND EUROPEAN SOLDIERS OF OUR INDIAN FORCES."

By Major-General VINCENT EYRE, C.B., R.A.

MUCH has been said and written during the past year about employing a portion of our Indian Native Regiments, more particularly those composed of Sikh and other Punjabees, in assisting to guard our Colonial possessions in various parts of the globe; some having gone so far as to advocate their employment in Europe, and even in England itself; and as these suggestions have apparently emanated from persons more or less acquainted practically with the constitution and temper of those troops, and have excited considerable attention in this country, it is highly desirable that they should be carefully examined and sifted by competent men both civil and military, for which this valuable Institution affords such favourable opportunities, in order that such facts and arguments may be elicited as shall place the matter, in its various aspects, clearly before the public.

Should time admit, there are some other equally important and not less interesting questions connected with our Indian forces to which it is my intention to allude. We seem, indeed, to be on the eve of great changes in our military system both at home and in India, to suit the novel requirements of the times in which we live; and it appears to me desirable that the members of this Institution, comprising so many experienced officers of all grades and services, should, as far as in them lies, cast their ideas into the general stock, and thus supply a few of the necessary materials wherewith to build up a new edifice for the benefit of their common country.

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For these reasons I have been induced, at the instigation of some members of our Council, to pen these few paragraphs, not from any assumption on my part of any better claims to attention than a career of thirty-four years of continuous active service in India may fairly entitle me to, but solely for the sake of promoting some opportune and profitable discussion, and of stirring up other more competent gladiators to the combat.

Let us then consider, in the first place, the adaptibility of the Sikhs and other Punjabee soldiers for the purposes already suggested. Few require to be informed now-a-days about the origin and history of this famous race of warriors; the bravest, the hardiest, and the most formidable with whom the British forces in India ever came into conflict. It may be as well, nevertheless, by way of remembrancer, to give a brief preliminary sketch of the rise and progress of this remarkable people, that we may be better prepared to estimate their present and future value as supporters and defenders of the British rule, to which they now owe allegiance.

Centuries before the English appeared on the scene, the Punjab had been a battle-ground between Mahomedans and Hindoos. In these latter times the population has been estimated at ten and a half millions, of whom two-thirds are Mahomedans and the remaining third Sikhs and Hindoos. The Sikhs were, indeed, originally Hindoos themselves, but towards the end of the 15th century, under the stirring teaching of their great apostle NANUCK, and to a still greater extent two centuries later under that of his saintly successor, the great Sikh Reformer GOVIND GOOROO, they renounced the trammels of caste and the debasing practices of idol worship, and formed themselves into a military sect, in religious subjection to the doctrines and guidance of the latter, as set forth in the holy book known as the "GRUNTH."

The term "Sikh" means simply "disciple," and the surname of "Sing" or "Lion," which they universally adopted, was meant to denote that soldierly prowess on which they chiefly prided themselves, and for which they soon became so distinguished. Under the influence of a less degrading faith (somewhat resembling pure Deism), more substantial fare, and the martial spirit which was ever kept alive, they became more robust and enterprizing than the Hindoos, and gradually their speech became distinct from that of their surrounding neighbours, of which it is a corrupt medley. Captain Cunningham, in his interesting, though somewhat too partial history of the Sikhs, thus writes of them in 1849: "A living spirit possesses the whole "Sikh people and the impress of GOVIND has not only elevated and "altered the constitution of their minds, but has operated materially "and given amplitude to their physical frames. The features and "external form of a whole people has been modified, and a Sikh Chief "is not more distinguishable by his stately person and free manly "bearing, than a minister of his faith is by a lofty thoughtfulness of "look which marks the fervour of his soul and his persuasion of the "near presence of the Divinity." Wilson, a less enthusiastic admirer of the Sikhs than Cunningham, describes them as still to a certain

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extent Hindoos, celebrating all the festivals of the latter, and paying great veneration to Brahmins. However that may be, we must, at all events, give them credit for having made a very considerable stride in the right direction, and far in advance of the great mass of their countrymen.

At the close of last century, Runjeet Sing, the famous "Lion of the Punjab" became ruler of Lahore, and rapidly extended his dominion over the land of the five rivers. His conquests would probably have spread over Hindostan also, but for the growing power of the British which he had the sagacity to appreciate at its true value. In 1809 he concluded with them a treaty, pledging himself to keep west of the river Sutlej, which treaty he faithfully kept. He died in 1838, leaving behind him a most formidable army, which having been trained and disciplined under the teaching of able French officers, became a powerful instrument for evil in the hands of his weak and incapable successors.

With no master mind competent to command respect and obedience, these Prætorian bands soon burst the bonds of due control and assumed the part of dictators. Filled with overweening confidence in their own strength, and, above all, in the invincibility of their numerous and magnificent artillery, encouraged moreover by a remembrance of the recent reverses suffered by the British in Affghanistan, and, more than all beside, thirsting for the plunder of the rich and tempting plains and cities of Hindostan, which raid they had sworn sooner or later to accomplish, this ungovernable host suddenly assumed the offensive, and without any just or adequate cause of quarrel, crossed the Sutlej in immense force to try conclusions with their British rivals.

Fortunately the supreme power at this dangerous crisis was in the hands of an experienced soldier statesman equal to the emergency, and aided by a military chief of kindred spirit, whose career in many a hard fought field had been one of unvaried success. Hastily collecting all the available forces from the frontier stations, these two noble leaders advanced in person at the head of their troops to meet the invading foe. Throughout all India it was felt that the long foreseen struggle for mastery between the two great rival military powers of the period was on the eve of accomplishment.

At Moodkee the first shock of arms took place, but with no more decisive result than forcing an advanced division of the invader to fall back on the main body in a strongly intrenched position about 20 miles south-east of the British extreme frontier station of Ferozepore. Then followed the great and terrible battle of Ferozeshah, and never was the sceptre so nearly wrested from our grasp as on that hard-fought field. True we were considerably outnumbered both in men and guns, but not more so than had been invariably the case in former wars with other native powers, over which we obtained comparatively easy triumphs.

Never, indeed, had we taken the field in India with so powerful and well equipped a force. Yet the night of the 23rd December, 1845, closed over a drawn battle, each army holding its own ground till the

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following morning, when the struggle was renewed; and so critical was our position at one period, that the question of retreat was seriously mooted, but vehemently opposed by Lord Gough, as fatal, in its probable consequences, to the British rule. Happily, this determination of their veteran chief to maintain his ground at all hazards was shared by every British officer and soldier on the field, and eventually turned the long trembling balance of victory in our favour. The victories of Aliwal and Sobraon, which soon followed, rolled back the tide of invasion from British territory, and enabled us to dictate a treaty under the very walls of the Sikh capital.

But it required more than one campaign to convince the Sikh soldiery of the hopelessness of the struggle on which they had so recklessly entered. They were temporarily repulsed and checked, but very far from being really humbled. Within less than two years a great Sikh army was again in the field, with an array of guns little less formidable than before. The siege of Mooltan, followed by the bloody fields of Chillianwalla and Gujerat, again testified to the indomitable pluck and energy of these sturdy Punjab warriors. Chillianwalla was a series of desperate disjointed struggles or episodes, which took place very much at haphazard, but with little appearance of combined action, and with many strange fluctuations of fortune, during which the Sikh cavalry exhibited a degree of daring and enterprise which at one time threatened most serious results. Their guns, too, were admirably served; and although night found the British, masters of the field, yet, when morning dawned, both armies seemed to hang back from a renewal of the contest, though continuing to face and defy each other at a respectable distance, until the successful issue of the siege of Mooltan having liberated another British division, alarmed the Sikh commander into activity, for, suddenly turning Lord Gough's flank, with the design apparently of seizing Lahore, and perhaps marching on Delhi, he was promptly followed up, and eventually brought to bay at Goojerat, where a final and decisive battle terminated the career of the Sikhs as an independent power.

Goojerat was in fact little more than an artillery duel on a gigantic scale. For upwards of two hours the guns of both armies, about two hundred in number, pounded each other with incessant fury until those of the enemy were silenced. Then at last the veteran British chief, who had meanwhile curbed his own impatience and the impetuosity of his troops, saw that the fit time had come to let slip the dogs of war, and soon the whole Sikh army was in precipitate flight, leaving 56 guns on the field. Promptly followed up by Sir Walter Gilbert's flying column, 16,000 men, the sole remnant of the great Sikh army delivered up their arms and the remainder of their guns on the plain, and the war was at an end; and thus was the last great danger which threatened British dominion from without, removed.

As the best safeguard for future tranquillity, the Punjab dominions were permanently annexed to the British Indian Empire; the young Maharajah, Dhulleep Sing, being liberally pensioned. A board of administration was formed, whereof the late Sir Henry Lawrence

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was president. Prompt and vigorous measures were taken to disarm the population, and every inducement offered to their leading men to turn their swords into ploughshares and their spears into pruning-hooks; while an outlet for the martial tendencies of the military classes was afforded in several new local regiments on the irregular system, and in sundry police corps, which it was deemed politic to raise for the defence of the northern hill frontier, and for the preservation of internal order.

In a marvellously short space of time, this land, so long the theatre of misrule, turmoil, and violence, settled down into a state of calm, if not contented tranquillity. A new stimulus was given to agriculture and commerce, new roads and canals were opened out in all directions, and a tide of prosperity and improvement set in, which has been steadily on the increase up to the present time, and which even the troubles of 1857 did but little to interrupt.

The new Punjabee regiments, composed partly of Sikhs and partly of Mahomedans, with a sprinkling of Hindoos and Goorkhas, and subjected to the wholesome discipline and intelligent guidance of picked English officers, proved a most successful experiment. The new force soon established, and has since maintained, a first-rate reputation for efficiency and fidelity; and those same soldierly qualities which had rendered them the most formidable of foes, elevated them, when enlisted on our side, to the highest rank of merit in the Native Army of India.

In 1858 the Punjabee troops in British employ mustered, according to parliamentary blue-books, not less than 75,000 strong, of whom about 54,000 were irregulars, and the rest spread through the police. About one-third of the whole were Sikhs, and two-thirds Mahomedans. As far as I have been able to ascertain from the authorized Army Lists, the present available force of Sikhs and Punjabees in our military service consists of only about 20,000 men, independently of those scattered over the old sepoy regiments under the new organization. They are distributed as follows:—

In the Punjab frontier force and guide corps, about	10,000
In the Bengal Native Infantry under the new organization	10,000
Total	20,000

Of these I should think less than one-half are genuine Sikhs, the rest being Northern Pathans; hence it will be seen that the number of these born warriors enlisted in our service has undergone a vast reduction since the year 1858, so that we can scarcely be said, at the present time, to have any to spare for service out of India, unless indeed by raising new regiments to meet such a call from without. Should British India ever be invaded from the direction of Affghanistan, we could muster no better or sturdier soldiers (besides those of our own country) to meet the foe than those very Sikhs and Pathans of the Punjab, among whom border warfare has for centuries been a normal condition of existence. The Sitana campaign of 1863 against the mountain tribes north of the River Indus proved how admirably

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these troops are adapted for the defence of our frontier in that quarter. Sir Neville Chamberlain, in his despatches, has borne ample testimony to their fidelity and devotion, and although many of the Pathans engaged on our side on that occasion belonged to the very same tribes which were fighting against us, yet there was no instance of desertion or of backwardness in engaging the enemy.

It has been already remarked that the Sikh derives those distinctive qualities wherein his excellence as a soldier chiefly consists from his religious system. To what extent those influences which have heretofore operated in forming his character may be modified by the altered political circumstances of his condition remains to be seen; but it seems highly probable that the dispersion of the race over a wider surface, and the enlarged intercourse thereby established with men of other creeds, will gradually effect, if it have not already effected, a considerable change in that respect. It is notorious that the majority of those Sikhs who had entered the old Bengal sepoy regiments before the year 1857 joined with the mutineers, and fought against us at Delhi and elsewhere; although it is but just to mention that a faithful few, foreseeing the plot in preparation, took their discharge before the outbreak. On the other hand, all those attached to purely Punjab regiments, and separated thereby from the evil influences of disaffected Brahmins and Mahomedans of India, proved faithful to their salt. This fact assuredly seems to afford ground for believing that it may be our safest policy to keep our Punjabee soldiers in separate nationalities for the future. Hence, too, it may be doubted whether their wide dispersion over the Indian continent may not, by too closely assimilating them to our other subjects, operate injuriously, though by slow degrees, in depriving them of those special characteristics which we have found heretofore so valuable an ingredient in their composition. Indeed, I have been assured by an officer very recently attached to a Punjabee regiment quartered in the Western Provinces, that indications have not been wanting of late of a tendency on the part of some of our Sikh soldiers to relapse into the old caste prejudices of the Hindoos around them.

After Runjeet Sing's death, there being no strong master mind to exercise a controlling influence over them, the Sikh battalions repeatedly rose in mutiny, killing both European and Native officers indiscriminately, and it is highly probable that the example then set was not without its mischievous results on the minds of our own sepoys. But looking at the Sikhs as we ourselves have found them, rather than as they were apt to be under the exciting and degenerating influences of an unsettled Government, it must be admitted that we have ample grounds for confidence and trust. All who have seen them on active service agree that, whether employed as irregular cavalry, under such leaders as Probyn and Fane, or as light infantry on the irregular footing, they are not to be excelled. As artillerymen, their reputation stands equally high, but it has been our obvious policy since the lesson taught us by the mutiny, to keep our guns, with a few special exceptions, in the hands of our own countrymen, and Sir John Lawrence has well remarked that, "No mutiny of a native army, without guns, could

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hope to be successful," guns being an object of intense fear to the natives of the East, and for that reason objects also of adoration to the Indian gunner.

Punjaub soldiers will cheerfully march on the shortest notice wherever ordered, and have always been described as patient under fatigue and privation, and readily rallied in case of a reverse. No apter illustration of their readiness of resource under difficulties can be given than that recorded by Mr. Herwald Wake, C.B., in his public report of the celebrated defence of Mr. Boyle's house, at Arrah, when a gallant little band of English residents, assisted by 50 of Rattray's Sikh military police, successfully defied for a whole week three mutinous regiments from Dinapore, under the great Behar rebel Koer Sing. Mr. Wake thus writes:—"Every endeavour was made by the rebels "to induce the Sikhs to abandon us; heavy bribes were offered to "them, and their own countrymen employed as mediators. They "treated every effort with derision, showing perfect obedience and "discipline. During the entire siege, which lasted seven days, "every possible stratagem was practised against us. Incessant "assaults were made upon the bungalow. Not only did our Sikhs "behave with perfect coolness and patience, but their untiring labour "met and prevented every threatened disaster. Water began to run "short; a well 18 feet by 4 was dug in less than 12 hours. The rebels "raised a barricade on the top of the opposite house; our own grew in "the same proportion. A shot shook a weak place in our defence; "the place was made twice as strong as before. We began to feel "the want of animal food; a sally was made at night, and four sheep "brought in; and finally, when we ascertained beyond a doubt that "the enemy were undermining us, a counter mine was quickly dug. "On the 30th July the troops sent to our relief from Dinapore were "attacked and beaten back. On the next day the rebels returned, "and telling us they had annihilated our relief, offered the Sikhs their "lives and liberty, if they would give up the Government officers."

In acknowledgment of these signal services the Government promptly advanced the native officers a step in promotion, and bestowed on each officer and man a twelvemonth's additional pay. The whole corps has since been embodied as an integral part of the Bengal Native Army, under the name of the 45th Bengal Infantry. A detachment of 150 of these same Sikhs shortly afterwards joined my own small field force, for the attack of Koer Sing's jungle stronghold at Jugdespore, and thus I had an opportunity of personally witnessing their conduct before an enemy. What struck me most was their light-hearted cheerfulness, almost amounting to joviality, even under fire; the jaunty springiness of their step on the line of march, and the elasticity of their whole demeanour under fatigues and trials which usually cause dejection in men of other nations. They evidently loved fighting for fighting sake. One very prominent trait in their character I very soon discovered to be, their love of plunder, or "loot" as it is called in India. The day after the capture of Jugdespore, I was suddenly summoned to quell a violent quarrel among the Sikh officers, in the course of which they had actually drawn their weapons, and threatened to proceed to ex-

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tremities. I found that it originated in the discovery of some hidden treasure (about 20,000 rupees, or £2,000) regarding the partition of which they could by no means agree. Strictly speaking, they had no right to appropriate it at all, but, as matters stood just then in India, it would have been inexpedient to enforce that view, and it was quite sufficient for me to hint that if any further disturbance took place, I should solve the difficulty by claiming the treasure as common prize for the whole force, to allay their angry clamour, and they were soon restored to perfect good humour, as though nothing had happened to ruffle them.

Many other instances might be mentioned equally illustrative of the valuable qualities of the Sikh and Punjabee soldier. In the last Chinese war it is well known that the Sikh regiments acquitted themselves with signal valour in the field, and gave entire satisfaction in quarters; and it scarcely admits of a doubt, that whenever called upon for any special service, whether in China, Persia, Egypt, New Zealand, the Cape of Good Hope, or even in Europe itself, they would be found, if under equally good officers, equally manageable and effective. But many serious objections present themselves to the mind when considering the question of their employment out of India in time of peace as an integral portion of the national army of Great Britain; and I must confess that, to me, such an extension of their sphere of employment, at all events beyond the confines of Asia, except in special cases of emergency, as already suggested, appears a matter of very doubtful expediency. I believe that the oath taken by Punjabee recruits (both Sikh and Mahomedan) binds them to "march wherever directed, whether within or beyond the Indian territories;" but I apprehend the latter condition could only be intended to imply some urgent necessity of war, rendering such service indispensable for the security of the empire. Therefore their employment out of India in time of peace could only be fairly brought about, either by their volunteering for the purpose, or by Government raising a distinct force under new conditions, specially for colonial service. But, one striking characteristic of the Punjabee soldier is said to be that, while ready to start to the world's end at a moment's notice in search of adventure, and with the exciting prospect of fighting and plunder, he is less easily reconciled than even the Indian sepoy to a prolonged absence from his home and land, and when once the temporary excitement is over, is apt to get restless for a furlough. It therefore seems not improbable, that however flattered he might feel at the confidence reposed in his fidelity, he would, when the novelty was over, become impatient of his banishment, and heart-sick at the utter isolation his new position would entail; and such feelings, finding vent in his letters, might operate unfavourably on the minds of his countrymen at home.

I know it has been urged in favour of such a scheme that it might help in some degree to open the eyes of our native subjects to the enormous power and widely spread dominion of England, and to convince them of the hopelessness of struggling against our sovereignty in India. But I feel no great confidence that any such good would really result. If stationed at one of our colonies, they would

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obtain but a very limited insight into the secret of our power, and would find but little to dazzle their oriental imaginations. In fact, compared with what they had already seen in India, everything connected with their own profession would appear on an absurdly small and insignificant scale. Even in England itself it is to be feared the reality would fall very far short of their pre-conceived ideas. Of the regal splendour of a court, and of the "pride, pomp, and circumstance of glorious war," they would after all see nothing to compare with one of the Governor-General's grand durbars, or field-days, such as recently took place at Agra; while, on the contrary, they would, in the ordinary course of a barrack life in this country, constantly witness things irreconcilable, to their uneducated minds, with oriental notions of real power, and inconsistent even with that moral superiority for which they might have previously given us credit.

Some idea of the erroneous impressions to which simple-minded Asiatics would be liable in this country may be gained from the following extract, taken from that most entertaining book, "The adventures of Hajee Baba in England," by Morier, which, though not literally true, is understood to give an accurate picture of the early experiences of the first Persian embassy in London. Hajee Baba, the hero of the tale, thus relates one of his morning adventures; the scene being a street in London during the Burdett riots in 1810, on the occasion of Sir Francis being taken a prisoner to the Tower: "I was quietly proceeding along one of the "principal thoroughfares of the City, when I perceived a great mass "of troops in full march, accompanied by several pieces of artillery, "escorted by an immense mob of the dirtiest of the English, who "were rending the air with abusive words, occasionally assaulting the "soldiers with stones. I remarked that consternation appeared in the "faces of some, whilst others appeared totally unconcerned. 'What-"'ever is this?' said I to a man who had just stepped out of his "house to see the sight. 'Oh,' said he, 'I believe they are going to "'take up a man.' 'Only a man!' said I, 'if you require this to take "'a man, what must you require to take a city?' I was so im-"pressed with this strange scene, that I thought no more of my "private miseries, but immediately returned home in all haste. I "felt that the ambassador ought to know the state of things. 'At "'all events,' thought I, 'at the risk of getting more blows on the "'mouth, I'll tell him into what a state this country has fallen, and, "'if the rebellion which has evidently begun is not put down, he'll "'see the necessity of providing for our safety.'"

I quote this story not from any supposed value attaching to it as a fact (for it may have been altogether imaginary), but as coming from a writer thoroughly versed in oriental character and modes of thought, and therefore not unlikely to be a correct representation of what might actually take place under the supposed circumstances. And, who can say that our unsophisticated Sikh soldiers might not be fated to undergo many such strange alarms if quartered here in England, in these days of Fenian outbreaks, monster processions, and political excitement, and that the tendency would not inevitably be to shake

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their confidence in the power of our Queen, and in the stability of our Government? The natives of India can appreciate, and, above all things, reverence a strong Government; but a country seemingly governed by mob law, as, to their credulous and mistaken minds might sometimes appear to be the case with our own, would, I suspect, very soon cease to retain either their respect or obedience.

Judging then partly from my own experience of uneducated orientals, and partly from that of others, I should consider that a far more sound and salutary impression would be made on their minds by taking a telescopic view of our greatness and grandeur from a distance, through the medium of the imagination, than by a microscopic inspection of our littlenesses at close-quarters. As a general rule, all orientals, but especially the uneducated among them, when brought face to face with civilized life, are like fish out of water, and I see nothing in the character of our illiterate Sikh soldiery to induce me to believe that they would form an exception thereto. But, independently of all this, it can scarcely admit of a doubt that the employment of foreign Asiatic mercenaries of this description within these realms would be utterly repugnant to the feelings of the people, and opposed to the spirit of our institutions. No doubt, the martial and picturesque appearance of a regiment of Sikh cavalry at a review in Hyde Park, or forming part of the royal escort down Parliament-street, would excite the enthusiastic admiration of the mass of spectators and especially that of the ladies, and would convey to the minds of foreigners some just notions of the military resources of our Indian possessions and of the physical capabilities of their war-like populations; but I very much question whether all this would reconcile the British public at large to such an encroachment on their cherished rights and prejudices, as the presence of these strange guardians of the peace would involve.

There is, in short, but one mode in which an opening of this sort might be made, devoid of the objections already mentioned. An experiment on a small scale would be amply sufficient, and this would consist in selecting annually from the whole native army about half a dozen native officers of distinguished service and of superior intelligence as temporary Aides-de-camp to the Queen, to be attached to army head-quarters in England, except when required to attend upon Her Majesty on state occasions. Of course an English officer, conversant with their language and customs, should be attached to them. To men thus conspicuously selected and honourably employed, a year in England would be one continuous fête, and some good might possibly result from their favourable reports to their brethren in the east. A wholesome spirit of emulation might thus too be kept up among the whole body of native officers, and one probable result would be an anxiety to acquaint themselves with the English language and literature, of which they are at present wholly ignorant. The proportion from each Presidency should be as three, two, and one, for Bengal, Bombay, and Madras; for it should be borne in mind that there would probably be other candidates for such an enviable honour besides the Sikhs. I more especially allude to the native officers of

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the Scinde Irregular Horse (formerly so well known as "Jacob's Horse"), a body of much longer standing, who fought our battles in Persia and elsewhere with signal credit, who never once wavered in their allegiance, and who are, perhaps justly, considered by their own officers as the very *beau ideal* of soldierly excellence and loyalty.

Should, however, this country be involved in war, in Persia, Egypt, or any other quarter which might threaten the British power in the east, there need be no question about the employment on any such field, of such Indian troops as the Scinde and Sikh Irregular Cavalry, and the various regiments of Punjabee, Sikh, and even Goorkha infantry. Or, should Russia really threaten our north-west frontier, obliging us to drain our colonies of English troops to meet so formidable a foe, it cannot but be satisfactory to know that we might, for the occasion, substitute in all such localities as might be willing to receive them, as many native troops of the above description as could best be spared at such a crisis, although it must be remembered that all these troops, even if specially raised for the purpose, would be necessarily officered by properly qualified English gentlemen belonging to the Indian Staff Corps and local services, who would of course carry with them their rights and privileges, and I apprehend this might give rise to some difficulties and complications which have been apparently ignored or lost sight of by most advocates of the scheme. But, until such an emergency shall arise, there seems to be no particular object in altering the arrangements already existing for the protection of our colonies with British troops, unless indeed the present difficulty in enlisting recruits for the English army should unhappily cripple our military resources to such an extent as to render such aid from India indispensable.

In this latter case we might certainly substitute, even in these peaceable times, regiments composed of Punjabees or Goorkhas for some of the British regiments in China, Ceylon, Mauritius, New Zealand, and the Cape; although I consider there would be always a certain amount of danger in leading our Indian subjects to suppose that England had exhausted her own stock of soldiers, and was becoming dependent on her native Indian army for the defence of her widely-spread possessions in other parts of the world. And this leads me to another branch of my subject, viz., the continued maintenance in India of the present large European force, consisting entirely of Her Majesty's line regiments, and numbering 70,000 strong.

It was foreseen by many from the first, that there would in a few years be found a very serious practical difficulty in carrying out the amalgamation of the armies which took place in 1861. In that year I myself thus recorded my own opinions in an article written for the *Friend of India*:—"In April, 1857, the total European force in India "mustered 42,179; according to the lowest and most recent estimate, "its future strength must be maintained at somewhere about 73,500. "Thus the annual drain on our home population will be henceforth "nearly doubled. Meanwhile, the conditions of military service have, "by virtue of amalgamation, undergone a material change. Whereas "formerly a term of service in India was regarded by a soldier of the

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"Royal Army as only a possible contingency, which it might or might "not be his fate to undergo for a limited period, it must in future be "considered by the majority as an unavoidable certainty, for which "every recruit would do well to be fully prepared on first enlisting." And now, after six years' experience of the new system, I find it broadly asserted by a writer on our "Home Defences," in *Macmillan's Magazine* for February, "that India is a bugbear both to officers and men."

The writer in *Macmillan* proposes, as the best remedy for the evil, that we should retrace our steps, and go back again to the old system of a local European army; but another talented writer on the same subject in *Blackwood's Magazine* for the same month goes further still, and would, to quote his own words, "separate absolutely and by "an impassable gulf, colonial and Indian service from home service." He would have not only India, but our colonies all over the world, "provide for their own defence in peace time, just as they, in other "respects, manage their own affairs." "As to India," he adds, "it is "rich enough to hire again, as it hired of old, as many European "troops as are necessary to form the backbone of a great military "power." This writer considers that the European army of India need not exceed in number 45,000 men, with a reserve in England of 15,000 men, making a total of 60,000 men. He argues that, "in "assigning a garrison of 70,000 Englishmen to British India, we are "attempting too much. The drain upon our youth is heavier than it "will stand, and greater than the necessities of the case require."

There is indeed evidence enough on all sides that a vast change of opinion has come over the people of this country, without regard to party, since the amalgamation took place; and that if the reconstruction of our Indian armies were now, as then, under consideration for the first time, it would be very differently carried out. But to recede in legislation is always an unwelcome task. Nevertheless, the difficulty is one that presses upon us more and more year by year, and must be grappled with and overcome, and that soon, if we would retain our position as a great power in the world, and the integrity of our empire in the East.

It is perhaps presumptuous in me to differ from the admirably expressed views of the article in *Blackwood*, wherein it is easy to trace a master hand: but the present seems a favourable opportunity for suggesting what seems to myself a more simple and favourable method of dealing with the question of again localizing an European force in India, without violently upsetting the present order of things in that country; and here I will venture to remark that India is a dangerous country in which to be perpetually trying new experiments. Our native subjects are keen observers, and very apt to mistake our irresolution for weakness. Scarcely six years have elapsed since we abolished the old system of a local army, and ever since then we have been perpetually making changes, until the whole military fabric of India has become a gigantic patchwork, or, in poetical language, "a mighty maze," I wish I could add, "but not without a plan." There is indeed not so much *one* plan, as a multiplicity of plans, which

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have been hastily combined to form one confused and incongruous whole.

In fact, there have been too many cooks at work, and the wonder is, that so little mischief has been done, and so much real good been effected. If I offer myself to swell the number of cooks, I can only hope that, amidst the confusion which reigns in the establishment, I shall find myself not altogether "out of place."

I consider, then, that it is neither desirable nor expedient to cut asunder the link that unites the armies of England and of India; on the contrary, I would unite them still closer. India is our great school for officers, and above all, for generals; where Clive, Lake, Wellesley, Combermere, Sale, Gough, Napier, Havelock, Clyde, Strathnairn, and a host of other illustrious men* obtained their most valuable lessons in the art of war, and where scores of promising officers are still learning to emulate their brilliant achievements. Were the officers of our home army separated by an "impassable gulf" from service in India, they would necessarily lose the benefit of that admirable school, and must fall back on such lessons as they could acquire at Aldershott and the Curragh, which, I fear, would prove a very inefficient substitute.

If, then, the experience of the past six years has really proved the present system of supplying India with European troops to require modification, as so generally asserted, I think a very salutary change might be effected without the separation of any limb or the intervention of any gulf. My plan for that purpose would be very similar to one which I proposed in 1859 in the *Times* of that period, and of which the late Sir Howard Douglas made favourable mention, as "deserving of consideration," in his last essay entitled the "Defence of England," published in the following year.

I may mention, at starting, that should the idea broached in *Blackwood's Magazine* of a local force for each colony ever find favour with the Government of this country, it would greatly facilitate the practical working out of my own scheme as regards India, which country is held by us on a footing so wholly different from that wherewith we retain our colonies, that a system applying very well to the one would probably be found quite inappropriate to the other. Such important and self-supporting countries as Australia and Canada have now become, with a large and ever increasing European population, consisting chiefly of emigrants from the mother country, may well be able to raise and support efficient local armies for their own defence in ordinary times; and should such an arrangement ever take place (as I conclude must be the case sooner or later), the sphere of duty for the English army will be very greatly curtailed, and our ability for maintaining an efficient European army for India will, in proportion, be largely increased. No doubt, too, the completion of the railway system throughout India will eventually enable us to hold that country with

* I purposely omit from this category such well-known names as Pollock, Nott, Outram, Malcolm, and many others who achieved their world-wide reputation as officers of the Indian local army.—V. E.

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fewer European troops, provided the railways themselves be effectually guarded by a dependable body of mounted police, with rallying points at certain intervals, and the sooner some well-devised plan of protection is organized for that purpose the better; otherwise this anticipated new source of strength may, in reality, prove only one of weakness.* Meanwhile, it is obviously expedient that we devise some system whereby a prolonged service in India may be rendered more attractive to the mass of our soldiers.

I will now quote that part of my original scheme which, I venture to think, might still be made applicable, with a few modifications, to the present time:—

"The attention of British statesmen has of late been fairly aroused "to the necessity of providing effectually for our home defences "against the possible dangers of invasion. During the perils that "recently beset our Indian empire every available regiment was sent "out, until England and her colonies were almost denuded of troops, "and it was deemed expedient to raise several additional battalions "(about 24, I believe) for home service, to supply the deficiency until "the pressure from without should cease. But, as by general consent, "the safety of India demands the maintenance there of 60,000 to 80,000 "European soldiers, whereof it is proposed that about one-third should "be locals, there seems every chance of the aforesaid additional battalions being maintained as an integral part of the British Army. They "are at present, however, considered as temporary excrescences, under "the designation of second battalions of certain regiments of the "line.

"My proposal is to alter their constitution in such a manner as to "dovetail with our local force in India, or to have in their stead a "certain number of permanent 'garrison battalions' expressly for "home defence, and to raise a corresponding number of 'Indian battalions' expressly for local service in India; the former to act as "recruiting depôts for the latter. The system of promoting by seniority "should, I think, prevail in both these local services alike, and exchanges should be freely allowed between them. (Indeed there need "be but one cadre of officers for both battalions, which would effectually "prevent any difficulty on that score.) Under this system the home "battalions would be at once recruiting depôts and nurseries for our "Indian regiments, and arks of refuge for our veteran heroes after the "latter have undergone a sufficient quantum of exposure and buffeting in India. By this reciprocity of interests both countries would be

* In a very timely volume on the "Military Questions of the Day," published since the delivery of this lecture by Lieutenant-Colonel Sir Henry M. Havelock, Bart., that officer urges the extensive employment of "European mounted riflemen" to supplement our railway system in India. Such a force, he says, "would, by constantly "patrolling, keep the railways intact from being torn up, a duty which neither British "infantry nor native cavalry could perform equally well. The railways would help "to forward the mounted riflemen, horses and all, rapidly to the point from which "their own special movement would begin; each branch of force would thus help "the other. But *without* mounted riflemen, a widespread system of railways, not "being capable of being properly guarded, might prove a delusion and a snare, "rather than an aid in military operations against *insurrection*."—V. E.

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"gainers; India would gain a constant succession of healthy young "soldiers, ready disciplined and prepared to do credit to our country "and service in the east; while England would obtain for her own de- "fence a constant supply of home-sick, yet still efficient and valuable "*veterans* experienced in war, with medals on their breasts, and loyalty "in their hearts, to stimulate their younger brethren, and 'show how "'fields were won.' Each service would take a pride in and reflect a "glory on the other; the successes of either would be causes of "triumph to both, and thus would the army of India be indissolubly "*wedded* to that of England, by a never-failing of mutual interests "and mutual regard.

"Thus too would the India local service again attract the better "classes of recruits who now hold aloof, and would at once attain a "*locus standi* sufficiently distinguished to inspire its own members "with pride, and the sister services with respect.

"I see nothing in this scheme but what is practicable and advan- "tageous to both countries and both services. It can scarcely be "needful to point out the manifest advantages that would be secured "for the mother-country by maintaining a permanent local force for "home defence. It might be made to consist almost wholly of "veterans who have already established some claims to comparative "tranquillity at home. Such a body of men and officers in cases of "real emergency would, from their experience in war, be found fit "guardians of their native land, and would inspire in all around them "that calm and happy confidence which is so often the harbinger of "victory."

Such, then, is the outline of my scheme, and should the principle on which it is based be admitted as correct, I feel assured there would be no insuperable difficulty in carrying it into practical execution. That principle is, in fact, simply one of DOUBLE REGIMENTS, which, like the Siamese twins, should be connected with each other by an indissoluble link. It would be found equally applicable to our colonies, since each colony might have its own local force with its representative regiment at home. It already exists in the artillery, which, like a gigantic banyan tree, has its parent trunk permanently fixed at Woolwich, and its family ramifications all over the world, with "Ubique" for their common motto. At all events, I venture to offer the scheme, such as it is, for the consideration of any brother professionals and of my countrymen at large, without entering into further details that might be wearisome to my present audience.

Before concluding, however, I would ask permission to offer a few remarks on another kindred subject of some importance to our European soldiers in India; and here again I will quote from a paper penned by myself while in India six years ago, for I feel that it still expresses, as forcibly as I am able to put it, a most important question which cannot be too often or too perseveringly urged on the rulers of this country, viz., "the question of military colonization."

"Must India," I ask, "continue to drain the life blood of England "and expend the thews and sinews of her sons for the maintenance of "our power in the east, and yet are we never to *take root* in the country

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"we hold at such a costly sacrifice?—The time has arrived when we "must awake from the lethargy of a century and avail ourselves to the "utmost of the advantages which, for wise and beneficent purposes "have been placed within our reach. Now or never we must begin to "plant the available offshoots of our European population in the posi- "tions best suited for their healthy and vigorous growth.

"If we are continuously to pour the living mass of our standing line "army into India as a necessary portion of its service, we must devise "means to make the country more attractive to the soldiers of that "army than it has heretofore been. We must open to them a career, "with a hopeful termination discernible in the distant perspective.

"Let, for instance, every British regiment in India have its coloniza- "tion fund; let every soldier be made to feel the pleasant assurance "that by husbanding a portion of his pay in that fund, and by estab- "lishing for himself a character for sobriety and good conduct, he will "stand a fair chance, at the expiration of his service, of settling with "his wife and children in a permanent home, on land provided for him "by the State on certain conditions, and subject to military regulations, "in a community of his own countrymen, selected like himself for good "character, and with the means, if he choose to avail himself of them, "of earning by the sweat of his brow, or by whatever useful acquire- "ments he may have mastered, a decent competency for himself and "family.

"To ensure success for such an experiment, strict selection with "respect to individual merit and personal fitness for the work, must be "the invariable rule whereby to regulate the admittance of a candidate "to a colony. Each regiment should furnish periodically a list of can- "didates so qualified, for the information of Government.

"In addition to the above tests, the knowledge of some useful trade "or handicraft, the possession of sufficient pecuniary means to supply "the pecuniary requirements of a settler's life, and general apti- "tude for the peculiar condition of a colonist, should be taken to "account.

"For the first experimental colony begun on any such plan, a suffi- "cient number of worthy candidates would, I believe, be forthcoming "without difficulty, at the call of Government, to act as pioneers of "civilization, should any really sound and practical scheme for military "colonization be set on foot by competent authority. I use the term "'military' advisedly; convinced that the principle it involves is "essential to the success of any colony founded in India, for it implies "that all important *something* without which the best soldiers very soon "degenerate into a disorderly rabble. Soldiers who have been accus- "tomed for many years of their lives to go like carriage-horses in "*harness*, would often feel absolutely helpless without a driver; and "there are few gregarious situations in life where human beings, "whether they be soldiers or civilians, are collectively concerned, in "which *discipline* would not be found a decided advantage.

"Therefore, should the superintendent of each colony be a retired "officer of the army, and one who understands something of European "soldiers; let him be vested with plenary magisterial and special

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"powers, and be competent, both by character and position, not only "to command respect, but also to enforce obedience.

"To those who would pre-judge and condemn, such a project as "'quixotic,' I say, give it at least a fair trial! In other countries we "English have proved ourselves eminently successful as colonists, and "so far from the antecedents of a soldier's life disqualifying him for "such a career in the temperate and hilly tracts which abound in India, "I maintain that under wholesome restrictions, he is more likely to suc- "ceed than an unlicked clodhopper or an unbridled artizan. The one "great evil to be avoided is drink. Let only steady sober men be "selected, and let the strictest rules be enforced against drunkenness, "even to the extent of imprisonment and expulsion."

About the very time when I was thus earnestly urging on the attention of the ruling authorities in India the arguments you have just heard, it so happened that another officer was engaged, quite unknown to me, in drawing up a most ably written article on the same subject for the *Calcutta Review*, wherein he entered very fully into the practical details necessary for carrying out a complete scheme of military colonization in the hilly and temperate tracts of India most suited for the purpose. Although dated a little prior to my own paper in the *Friend of India* that number of the review was not actually published until a month or two later, and it was most encouraging to find my own views shared in, if not anticipated, by a writer who had evidently devoted much more attention to the practical minutiæ of the subject than myself, and who seemed to possess all the ability requisite for carrying out such a project. I have only very recently been assured that the writer of that article was Captain Knollys of the 93rd Highlanders, whom I believe to be now in England, and I hope he will kindly pardon the liberty taken with his name by an entire stranger, and that he may be encouraged to persevere in the noble task so zealously entered upon six years ago, and which deserves the cordial support not only of every soldier's friend, but of every man who wishes well to the permanence of our rule in British India. It is pleasant to me to reflect now, that I did my best to draw public attention to his project, of which I trust we may soon hear more full particulars from himself. Meanwhile I cannot do better than repeat here the last paragraph of my own review upon it in the *Friend of India*, which is equally applicable now as then. "The entire article "is worthy to be read and seriously pondered over by those who guide "the fortunes of India, and who now have a noble opportunity of ini- "tiating a new era, big with future promise, in the Government of the "country under British rule. To them and to our statesmen generally "we commend the early consideration of this great question. With a "hopeful progeny of infant colonies around us, we shall at last begin "to believe that we really have, like the Emperor of the French, a "*destiny*."

In the Journal of this Institution for October, 1866, will be found two admirable lectures, delivered in this room on the 4th and 11th of May last, by Dr. Mouat, on the "British Soldier in India," containing much valuable information on the facilities that exist for such military colonies

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as I am now advocating, and referring to my own slight efforts in 1861 to pave the way for their introduction. From some correspondence which took place in India on this subject, between myself and the Commander-in-Chief, Sir Hugh Rose, now Lord Strathnairn, I have good reason to believe that his Lordship would be found friendly to any movement in this direction which might now be set on foot in this country. The time seems more favourable now than then. Waste lands are more easily available for Europeans; the rapid extension of tea, coffee, and cinchona plantations in the hills has already caused an influx of European settlers to a moderate extent. The cultivation of those plants involves no very hard labour, and would afford suitable out-door employment for old soldiers, under competent guidance. Why, then, should not a beginning be made at once, under the auspices of the Government of India, and thus let it be known far and wide among our recruiting districts throughout the United Kingdom that, amid those healthy and magnificent mountains, whose glorious summits of perpetual snow are visible from a distance of more than 200 miles, and which overlook, like giant sentinels, the rich and populous plains of India, presenting an irresistible barrier of strength and security to its inhabitants, let it be known, I say, that in that most beautiful region of the earth is perched, high above the debilitating influences of tropical heat and miasma, ready for the reception of our brave soldiers after the toils of active service are at an end, nor for themselves only, but also for their children after them, that long yearned-for desideratum, a "SOLDIER'S HOME."

I must now conclude, asking pardon of my audience if I have trespassed too long upon their patience. The importance of the subjects which I have so cursorily treated, rendered it difficult to condense what I had to say into smaller compass. I only trust that this, my slight labour of love, in behalf of an Army wherein I have spent so many happy years of my life, may prove not altogether devoid of interest and of profit.

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Evening Meeting.

Monday, April 29th, 1867.

VICE-ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 8th and 29th April, 1867.

LIFE.

Keppel, W. A. H., Lieut., Norfolk Militia Artillery.

ANNUAL.

Bancroft, W. C., Major 16th Regiment. 1*l.*

Torry, Frederick S., Captain 25th K. O. Borderers. 1*l.*

Dampier, C. L. M., Ensign 25th K. O. Borderers. 1*l.*

Hutchinson, A. J., Ensign 23rd R. W. Fus. 1*l.*

Brackenbury, Henry, Captain Royal Artillery. 1*l.*

MacGregor, C. M., Lieut. H.M., Bengal Staff Corps. 1*l.*

Hamilton, T. Bramston, Lieut. Royal Horse Artillery. 1*l.*

Worcester, H. A. W. F. S., Marquis of, Cornet Roy. Horse Guards. 1*l.*

Dundas, Lawrence, Cornet Royal Horse Guards. 1*l.*

Hardie, H. R., Lieut. Haddington Militia Artillery. 1*l.*

LESSONS FROM LISSA.

By Commander P. H. COLOMB, R.N.

IT was well observed by a writer in the "Saturday Review" last year—from whom I have taken the liberty of borrowing a modified title—that "the moral of the great Prussian victory" of Sadowa "has been dwelt upon so constantly by the press of every European country, as almost to throw into the shade the not less striking lesson to be gathered from the Italian defeat in the waters of the Adriatic." Indeed few of those who are accustomed to look without prejudice on the great military and naval questions of the day, can have avoided a feeling of surprise that the great sea-fight of Lissa produced so small and so evanescent a commentary at the hands of persons qualified to deal with it. For it is impossible, on mature reflection, to avoid the

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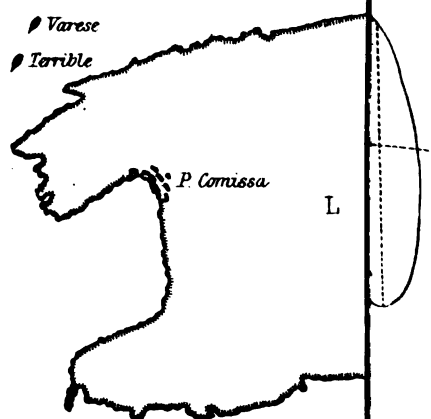
Fig. 4.

Position of Italian fter a

Fig 3.



J. Jobbins

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conviction that the battle of Lissa is, beyond all bounds, the most important naval occurrence since the great day of Trafalgar. Whether we regard the nature of the forces engaged; the manner of their employment; or their magnitude; we cannot fail to be struck with the thought that the great experiment for which all maritime nations waited, has been tried, and that the path which naval warfare will in future follow, is no longer hidden in the mists of controverted opinion.

The bombardment of Algiers, and the battle of Navarino, the operations of the combined fleets during the Russian war, which, taken as a whole, bear a certain professional value—altogether fade in importance before the combat in the Adriatic. No naval man can turn to Algiers and draw thence a professional lesson applicable to the present day. He may watch and admire the example of consummate daring there displayed, but he must reflect that bravery is born in the soul, and does not come from outward schooling. We may all recollect how the false analogy of Algiers was used by the press as a goad to stimulate the supposed want of enterprise of our Admirals during the Russian war; and the futile attack on the sea forts of Sevastopol may warn us of the uselessness of accepting superficial teaching.

The battle of Navarino, between the forces of advancing and retrograding powers, begun without plan and continued without combination,* serves as no model for our imitation.

The operations conducted by the western navies during the Russian war, with ships only partially embodying modern improvements, in exceptional situations, against exceptional opposing forces, how shall we draw from them any elements by which to guide ourselves in future wars? But more than all, we must carefully reflect that such a sweeping change has passed, or is passing, over modern navies, that the chain which has bound us to the past may easily be assumed to be broken; if any links remain, we may be sure they do not lie immediately on the surface, and it must be weary, and may be unprofitable, to follow too closely any analogy offered by former naval battles to what is assumed to be their future conduct.

In one respect the battle of Lissa is probably of insignificant proportions. Its political effects were overshadowed by other dominant circumstances; and should it secure an influence in that sphere, which it does not now possess, few will be able to trace that influence to its source.

The position I assume in attempting to draw out for discussion, what appear to me the salient points of this battle, is a very simple one. I wish to look on the battle entirely as one for scientific examination. In this Theatre we have nothing to do with the *argumentum ad hominem*, and therefore praise or blame shall not escape from my lips, nor will it, I hope, escape from those who may take part in the discussion. We may the more easily avoid this dangerous ground by reflecting that the Lessons from Lissa are not to be drawn from the

* This remark simply refers to the fact, that until fire was opened, it was not known whether there would be a battle; and is no reflection on any Officer concerned. May 14.—P. H. C.

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consideration of any political necessities which directed an attack on a fortified island in the presence of an intact floating force; nor are they to be drawn from the personal characters of those in the respective fleets, or one might also say from their personal conduct, except in so far as it concerned the application or disregard of certain purely scientific principles, which I hope to make plain to you in the course of this paper. Again, the path is comparatively easy to us, if my opinion be correct, that the real lessons of the combat are to be drawn entirely from that part of the battle comprised between the near approach of the Austrian fleet and the sinking of the "Re d'Italia," a period extending over a comparatively short portion of the three hours and a quarter, said to include the whole battle from first to last. I must beg your indulgence, if, in referring to a paper of mine read in this Institution previous to the battle of Lissa, I seem to ask you to view me in the light of a true prophet.* It is in a manner obligatory on me to quote from it as forming a link in my chain of argument, but I wish to be understood as referring to it simply as I would refer to any other writings which answer the same end. I shall not go into any details respecting the battle, because such are quite unnecessary for my purpose, and also because I believe we are to have the historical record drawn out for us by very much abler hands than mine. But in order to get at the lessons taught us, I must mention the broad features of the battle, and I shall, at each stage, make what appear to me the reflections properly raised thereon.

The Italian fleet, consisting of four completely iron-plated ships, seven partially so, one turret-ship, seven wooden frigates, and fifteen smaller vessels, left the Italian ports chiefly on the 16th of July, 1866, for a concentrated attack upon the Austrian island of Lissa. This attack actually commenced on the 18th, and continued throughout the 19th, with varying success. On the 20th the ships were gathered on the northern shore of the island with the intention, should it be possible, of effecting a disembarkation to the westward of Port San Giorgio before the arrival of the Austrian fleet.

Meanwhile, the Austrian Admiral Tegethof, had been lying in Fasano roads at the head of a fleet composed as follows:—Seven iron-clads, one wooden line-of-battle ship, five frigates, and thirteen smaller vessels. He had early received intelligence of the impending attack upon Lissa, but at first considered it as a feint, having for its object to draw him from his base of operations. A telegram, however, reached him on the 19th, which no longer left it open to doubt that a real and persistent attack was intended upon the Austrian island; and about noon he put to sea with his whole fleet, having apparently fully made up his mind to save Lissa or be himself destroyed.

The Italian fleet received news of this movement, on the same evening, but it was hoped that the disembarkation and capture of the

* "Modern Naval Tactics;" see *Journal of the United Service Institution*, vol. ix., page 1.

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island might be concluded before the approach of the Austrians, thus releasing the Italian fleet to meet them.

The morning of the 20th July broke stormily and wild, the wind from the S.W. with heavy rain squalls. The arrival of a battalion of marines in the "Piemonte," decided Persano to push the final attack with all speed, and the necessary orders had actually been given, when at about 8 o'clock the "Esploratore" which had been stationed to look out in the N.W. quarter, re-appeared from a passing rain-squall which had hidden her, with the signal flying announcing suspicious ships in sight.

The position of the respective fleets appears at this moment to have been as follows. The Austrian steering S.E. by S. at a moderate speed, was in three divisions astern of each other. Each division was in the angular formation, or what it is now proposed to term "two quarter lines," as shewn in fig. 2 (plate v.), the angle formed between the two wings of each division was very obtuse, so much so as to give the Italians the idea that the ships were in line abreast. The divisions were about 1000 yards apart, and in the rear of each was a small ship for repeating signals.

The Italian fleet was in a scattered state along the northern shore of Lissa (fig. 1). Of the eleven ironclads, two, the "Terribile" and "Varese," were at too great a distance to the westward to be in time to have any important influence on the approaching combat. A third, the "Formidable" had suffered considerably in the previous day's bombardment, and was fully engaged in transferring her wounded to the hospital ship. This left nine ironclads in a position to meet the approaching seven of the Austrians. The Italian wooden ships were closer in shore, engaged with the impedimenta of disembarkation. These ships took no material part in the affair, and adhering to the rule I have laid down, there being no particular lessons to be derived from an examination of their proceedings, it will be sufficient thus to account for their absence from the main part of the action. It is perhaps advisable to recollect, that while the Austrian fleet was complete with coals and ammunition, and the crews were fresh and intact, the Italians had had a large expenditure of the former necessaries, and had suffered a loss of 16 killed and 95 wounded, while their crews were probably harassed by the previous day's bombardments. The forces which were really about to fight the battle of Lissa were, therefore, on the Austrian side:—7 ironclads, not of first-rate model, with an aggregate burthen of 27,200 tons, an aggregate power of 4,750 horses, a broadside of 88 guns, and 2,884 men.

On the Italian side were:—9 ironclads, all of new construction; of greater speed and generally of heavier plating than the Austrians; a combined tonnage of 38,500; a power of 6,000 horses; a broadside of 103 guns; and about 4,000 men.

Now, from a comparison of these forces thus ranged against each other, I think we may fairly derive our first and most impressive lesson. On one side we have 103 guns opposed to 27,000 tons; on the other, 88 guns opposed to 38,000 tons. The destructive work cut out for each gun was, therefore, on the Italian side, 262 tons; and on the Austrian, 432 tons.

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Now, the Austrian tonnage, distributed as we should have seen it previous to the introduction of ironclads—allowing about 3,000 tons to a 90-gun ship—would have been represented by 9 of these ships carrying a broadside of 405 guns. The Italian tonnage, distributed in the same manner, would have been represented by 12 ships, carrying a broadside of 540 guns. The destructive work cut out for each Austrian gun would have then been 93 tons, in place of the 432 mentioned above: and the work cut out for each Italian gun would have been 50 tons, in lieu of the 260 before mentioned. That is to say, the Austrian guns should have been nearly 5 times, and the Italian guns, *more* than 5 times as destructive as those usually employed in two-deckers, in order to leave the artillery at the battle of Lissa in the position it had held as a weapon previous to the introduction of ironclads. I need not increase the force of this remark by pointing out that, while the mass to be destroyed was five times as great as usual on this occasion, the submerged and therefore invulnerable portion, was also greater than usual. No one will, I imagine, venture to argue that the artillery on either side at Lissa, far from exceeding the destructive capacity formerly attributed to guns, even approached it; and I think we can hardly exaggerate its enormous disproportion to the work it was supposed to do. But a wider question is raised by this simple examination. The proportion of work cut out for each gun at Lissa happens to be a fair example of what guns in any ironclad action will be required to undertake. If artillery is to retain its former destructive power, each gun must have a capacity for destroying ironclads at least five times as great as that possessed by the old patterns, for destroying wooden ships.

I have, I am sorry to say, never witnessed the effect of modern shot against modern ships' sides, and am not going to attempt to prove relative destructive effects, when shot strike. I merely take this as a first reflection suggested by the battle commented on, namely,—that without taking other elements into consideration than the number of guns relative to tonnage—either, each of our guns must do five times as much work as they used to do on wooden ships, or they have lost ground as weapons of war; and I may add to this, that an increase of 400 per cent. in the power of a gun is a heavy proportion to admit.

In considering the relative forces which were about to meet in action, we have to add to the Austrian side the wooden 92-gun ship "Kaiser," and her consorts, frigates and gun-boats, carrying a broadside of 177 guns. Had these ships been armed with guns capable of piercing the Italian plates, there might have arisen some difficulty in estimating their force; it being necessary to balance between their offensive powers and their extreme liability to injury, as evidenced by the fact of the "Kaiser" suffering two thirds of the whole Austrian loss. Their heaviest guns being, however, only capable of throwing a rifled shot of 60 lbs. weight, almost powerless against the Italian ships, we cannot be very far wrong in considering the Austrian wooden ships a source of weakness rather than of strength.

Perhaps this is the place to refer to another lesson from Lissa on

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the question of unplated ships with heavy guns, *versus* armour plates. I have seen it several times in print, and I have heard it often seriously argued by naval officers, that the battle of Lissa shewed the value of wooden ships against ironclads; and the "Kaiser" has been on such occasions quoted as having beaten off a combined attack of four of them. Granting she did this, what but her evident weakness invited such an attack? and what was the ultimate result of all her gallant endeavours? She was so near destruction that she was obliged to haul out of action. She lost her bowsprit, foremast, and funnel, had 22 men killed and 83 wounded; more than two thirds, as I before said, of the loss suffered by the whole Austrian fleet. In return for this damage, she tore away the boats, bulwarks, and port-lids, of the "Re di Portugallo" by collision, and riddled the upper works of the "Affondatore" by shot; when we have said this, we have perhaps said all. I cannot, therefore, see how we are to place anything whatever to the credit of wood *versus* iron plates in consequence of what occurred at the battle of Lissa. It is argued on this question that we may, by reducing armour-plating, replace the weight so taken away by adding to the number of plate-piercing guns. But I think it is forgotten that for every plate-piercing gun carried by the non-plated ships, the plated one may carry several light shell-guns of terribly destructive powers when opposed to unplated scantling only. As an extreme case we should then have a totally unclad ship, whether of wood or iron, carrying a few plate-piercing guns, against a completely-clad ship, armed with a multitude of light shell-guns, such, for instance, as the Armstrong 40-pounder. The power of the respective ships when in opposition would then be the number of rounds fired per minute, multiplied by the effective work done by a single shot. As the number of light guns carried, would be at least five or six times the number of plate-piercers, whilst the rapidity of fire would be possibly doubled, the question to be decided by those who argue in favour of non-plating would be:—Can you secure that each plate-piercing projectile shall do ten times the damage on the plated side of its opponent, that such opponent's shell will effect on the non-plated side? I think I am fairly understating the question in favour of the non-plated side, and it will be most interesting to hear from any qualified gentleman present, an estimate of the relative effects of the two species of ordnance quoted, against their respective targets.

I have stated, and illustrated by a diagram, the position of the two fleets when the approach of the Austrians was signalled by the Italian look-out ships. (Fig. 2.)

Persano formed his nine ironclads in line abreast with their heads to the westward, but afterwards passed into line ahead, steering about N.N.E., a course leading directly across that of the Austrian fleet. The Italian admiral now considered it advisable to shift his flag from the fourth ship in the line, the "Re d'Italia," to the "Affondatore," so as to better assume the command of the whole fleet. Admiral Persano has been much blamed for making this change. I will not presume to offer an opinion as to its prudence or imprudence at such a time, but if I be asked whether I consider the admiral is better placed as part of

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his battle formation, or as detached from it—then I can only here repeat the portions of my former paper referring to that point, and say the battle of Lissa has therein taught me no new lesson.

I said in my paper on Modern Naval Tactics, that—"If a general on land were restricted as an admiral is at sea, to the use of signals for the conveyance of his orders . . . . he would place himself where he could best see and be seen. . . . . I take the view that in future naval actions the Commander-in-chief will not take a position in the line. He will place himself in some swift, quick-turning vessel, not unarmed or unplated, but still a light ship—the flag-ship of the future—where he can best view the movements of his own and the enemy's fleet, and where his signals can be at once perceived from all quarters." I recollect that expression of opinion was received by the meeting with considerable approval, and I am sure we should all be glad to hear whether that approval is still given to the idea. If the "Affondatore," with her smaller tonnage, is assumed to have been a much handier ship than the "Re d'Italia," we may express an opinion on their relative values as flag-ships, and on the relative values of the positions, out of the formation, and forming part of it, without allowing ourselves to be drawn away from those points, by other considerations affecting the judgment of the Italian admiral.

The two fleets—the Austrian steering S.E. by S. or thereabouts, and the Italian N.N.E., neared each other so rapidly that Tegethof had no time to make a signal which he had prepared after the manner of our own Nelson, "as a fillip" to his fleet, but was only able to order the divisions to keep their distance at 1,000 yards apart; the ships of the divisions to close and go full speed; and finally to the ironclad division to bear down and sink the enemy. The respective positions of the fleets are given in the diagram, fig. 2. "Thus on the one part," says the article in the *Revue des deux Mondes*, which in spite of denial is still attributed to the Prince de Joinville, "we see the Italian squadron in a thin line, of the depth of a single ship only, drawn out to the length of 5,000 yards, presenting their broadsides to the enemy. On the other, the Austrian squadron in a compact mass closed up to a breadth of 1,200 yards, rushing upon the enemy at full speed with the advantage of wind and sea, to pierce him through and through. Such was the opening of the battle." Having brought the fleets into this position, I must again ask your indulgence while I quote from my previous paper, when I had imagined the results of a combat which Lissa realised in a great measure. I said, "But in order to set aside any lingering affection we may retain for the old line-of-battle as a fighting order; let us just recall the fact, that the serious part of a future naval attack does not appear to be the guns, but the rams. How will they affect the question? If we look into the history of all our naval actions, the decisive victories were gained, only when we succeeded in breaking through the enemy's line. The closest possible line-of-battle was the safest possible position, and an opening therein was hailed with joy by the attacking party as an earnest of success. . . . . But suppose an admiral in a steam fleet, some ships of which are rams, can we not well imagine his exulting in the certainty

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of victory the moment he saw a close line-of-battle neatly drawn up in the most convenient position possible for the action of the new and terrible weapon? The enemy could never be so foolhardy as to attempt such a proceeding; the approach of the rams would surely break up the line, for no captain would allow himself to be fairly run into when he could avoid it, and thus the great aim and end of all our great naval leaders would be obtained even before the action commenced."

Now I know I run a risk of being accused of egotism in making these quotations, and I could sincerely wish that some one else had used my words so as to have left me more free to deal with them. But the lesson I draw from the fact of such language having been used in this Theatre a year before any practical experiment took place, is so important that I cannot suffer any false delicacy to stand in my way. Officers present at the reading of my paper, might easily themselves have been placed within a few months in the position of the Italian officers at the battle of Lissa. Officers of rank who listened, might have had—and may still have to decide—what they will do with ships under their command, when their look-outs shall signal "The enemy in sight." The first question is, Can we not by close examination of *facts* distinctly establish the basis from which we must work? And next, Have we established such a basis?

Now as to the answer to the first question: has not what was stated by me—simply, as a naval officer who had given some study to the subject—shewn most clearly that if the tactics to be employed, "could not," to use Captain Selwyn's remark upon my paper, "be decided till the first action is fought," it was yet comparatively easy to say what was *not* to be done? I see nothing in any direction now, but absolute condemnation of the Italian line-of-battle as opposed to the Austrian attack. But I did not notice that my distinct condemnation of that formation for the purposes of defence, met with a reception sufficiently marked, to assure me that there was anything approaching to conviction on the subject in the minds of my hearers. I will go farther, and say that even now, in spite of the strong condemnation which is levelled at the Italian movement, the tremendous consequences involved in the abrogation of the line-of-battle as a fighting order, are hardly even considered, and the whole question is treated by a majority of the naval world as one of no moment! I have met with but one paper which clearly adverts to the matter; this is a very remarkable sketch by the French Admiral Touchard, in the January number of the *Revue Maritime*. I do not commit myself to all the details of his opinion there given, but it was curiously strengthening of my own, to find their echo in so independent a source.

It has been said that maritime warfare is in so changeable a state, that even supposing the principles of attack and defence could be clearly established to-day, some new invention or combination might to-morrow overturn them. This statement is made the excuse for avoiding the study of the question, for it is said that our minds might become trammelled by belief in certain theories, which, if true at the time of their birth, might be untrue when it became necessary to put them in

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practice. Now it must be admitted that there is some reason in this argument. There is every danger of our committing ourselves to a theory which will not serve our turn when the time comes. If our minds were a perfect blank on the subject, and could be kept ready for the reception of a new idea, when it was absolutely mature and ready to be implicitly followed; then we should perhaps be wise to lie by and wait for this complete arrangement of true principles to be presented to us. But unfortunately our minds are by no means blank on this subject. If we do not displace them by some theory of attack and defence more fitted to modern facts, we shall certainly pin our faith to the methods followed by our forefathers with materials altogether different.

The question is not whether we shall lie by and watch the signs of the times ready to bend them to our purposes on the outbreak of war; but whether it is wiser for us to go into action with our heads full of the tactics of Rodney, St. Vincent, and Nelson; or to come to questions of attack and defence with our heads full of what appear to be the strong and weak points of our modern arms.

As regards the changes in tactics produced by changing weapons; it must be recollected that these changes are not sudden, violent jumps, without any warning. They are, every one of them, matters of cause and effect; and I do not for a moment doubt the possibility of sketching out beforehand the *direction* in which changes may be expected to occur. Our Navy is not celebrated for prescience in material changes, and it is for this very reason that I would insist on more study being given to methods by which a greater approach to prescience may be attained. The establishment of a theoretical basis founded upon the most recent knowledge, is one of the first requirements of progress in physical science. It is not necessary that this theory should be true to make it valuable; but it must include and explain all known facts, and will be modified from time to time, as new facts arise, or perhaps exploded altogether when some truth comes to the surface which cannot be embraced by it, so in matters of professional science we must have theories to fit our known facts. If we cannot attack and defend ships according to some previously arranged theoretical basis embodying all we know of the facts we have to deal with, we may find ourselves mastered by some one who *is* able to do so. We exist as a Navy on the understanding that we know how to attack and defend ships in the best manner, and the best manner can only be ascertained by the establishment of a theoretical basis such as I have spoken of.

The answer to the second question, have we established such a basis? can only be a decided negative. So little study has been given to the question, that there are few of our superior officers whose opinions coincide; and certainly the Service generally cannot be said to hold any opinions at all on the subject; and I own that I should feel the greatest alarm for the honour of our flag if a maritime war arose in which it was engaged, while opinion was thus vague. If ever there was a battle where theory carried the day against no theory—it was Lissa—and if we gained from it no other lesson than the necessity for a theory—it would be one quite important enough for our reflection.

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I think it is plain enough that in assuming the line-of-battle as a formation in which to receive the Austrian attack, Admiral Persano had not displaced his old ideas of naval attack and defence, by any theory founded on the changed conditions of the naval service, and I have been told that curiously enough the question of the power of the ram as an element of naval warfare, was debated, much to its disadvantage, by the Italians previous to their sad experience of it. Time was, when I, in my own mind debated with the same result, but I am aware now that I had given it very little real thought.

We may now return to the proceedings of the respective fleets. The leading Italian division opened fire on the Austrians—it is said at two hundred yards,—but it is evident that the range must have been considerably greater, for the Austrians were going at least ten knots, and would therefore pass over the two hundred yards in forty seconds, and they yet had time to return the fire. On neither side was any important damage done, and the Austrian leading division passed through the Italian line between the third and fourth ships. As the Austrians touched none of the Italian fleet in their passage through, it is evident to me that there was a considerable gap between the third ship, the "Ancona," and the fourth, the "Re d'Italia." I notice in the Italian plan of the battle, that the interval between these two ships is made a little larger than between the others, but as seven ships, say nearly in line abreast, passed through that opening, the difference must have been more than a little. Two probable things account for this difference—first, that the "Re d'Italia" had originally eased her engines to allow the "Affondatore" to come up, and had not yet recovered her position; and, secondly, that the interval was purposely made by the "Re d'Italia" to avoid being run down by the Austrian ships. I have not seen it distinctly stated anywhere, but I put it to my hearers whether this is not a perfectly simple explanation of the harmlessness of the Austrian attack by rams in the first instance? It will doubtless occur to you here to require an explanation as to how the Austrian ironclads, bent as they were on running down their opponents, should have actually passed through the line at a point where there were no ships to run down! Again, a very simple and significant reason is at hand—they were returning their enemies' harmless fire by one equally futile, and were in consequence blinded and confused by the smoke of their own guns!

The position of the fleets was now as follows:—The Austrian in a still unbroken and compact mass, had divided the Italians into two separate parts. Three ships were on their port hand under one admiral, and six on their starboard hand, under the commander-in-chief. The firing seems to have become pretty general, and concerted movements were over for the present. The three Italian ironclads naturally turned to port to attack the weaker wooden Austrians, and the Austrian ironclads as naturally turned after them. The fleets being in this position, the Austrians having interposed their concentrated mass so as to separate the Italian divisions, it is the proper time to examine closely the causes which brought about this state of affairs;

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the strategic effects of the position in the combatants; and the lessons to be drawn from the circumstances.

I have noticed that in most quarters where the battle has been spoken of, the particular formation assumed by the Austrians—the division in two quarter lines—is not considered to have contributed much, if at all, to the result attained. In this opinion I fully coincide. In my former paper I endeavoured to point out that however valuable in theory as an attacking formation, this angular figure might be, it was so unwieldy and so difficult to maintain, that practically it was valueless. Since I gave that opinion I have had opportunities of making experiments in an actual fleet, with the fullest confirmation of those views. Such a formation can only be maintained by means of extraordinary attention, and speedily becomes obliterated by a slight change of course. But when I spoke of the theoretical strength of the formation, I, and those who had preceded me, were only dealing with the fire of artillery. Its value had not been considered when used as a form of attack by rams. I think at the outset we may condemn it safely from this point of view. If a body of rams is to be moved as a whole, and to attack as a whole, it is of the first importance that the formation assumed by them should possess the maximum of mobility, which we have seen the angular formation does not enjoy. In an attack by rams, there are I conceive, two distinct objects, either of which may be sought for. You may use the indirect effect of the fear of being run down so as to break the enemy's fleet into two parts, to place your own between them, and to concentrate by that means your whole force upon half the enemy's. This might be compared to an attack by column amongst troops. And the formation in fleets to assume, would be one resembling such a column: one not presenting a wide front, but having considerable length. The other attack by rams would be to employ their direct effect and to destroy the enemy's ships by actual collision. This attack may be compared to a bayonet charge on shore; and the proper formation for fleets must evidently be one analogous to the line. Little depth and a wide front.

The angular formation assumed by the Austrians was a sort of compromise between the two opposite formations, and, such compromises being usually failures in war, may it not in some degree account for the failure of the direct attack by rams as far as we have gone? The indirect effect was however secured. An inferior fleet armed with inferior guns, by the indirect action of a hitherto untried weapon, had broken the line of an enemy altogether superior in ships and guns, and had attained, almost without a casualty, the object which in ancient days was considered equivalent to victory! Is not such an occurrence worthy of our closest scrutiny? Shall we not be neglecting our plainest duties, as Naval Officers who may have the honour of the country placed in our hands, if we omit making every reasonable endeavour to view this extraordinary circumstance in its true light?

It is generally said, and it certainly saves the trouble of thinking, to continue to say, that the Italians ought to have stopped the Austrians

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by their fire; that their gunnery practice was so bad, that no data can be drawn from the fact that they did not. Gunnery it is said, was sadly neglected by the Italians previous to sailing for Lissa. At any rate the crews were newly raised men, who naturally could not be good gunners. Now I have not the slightest objection to receive this argument, provided those who thus account for the affair will begin at the right end. Unfortunately for my own peace at any rate, I have only found the argument stated thus: "The Austrian fleet advanced, and passed through the Italian, almost without receiving a scratch; *therefore* the Italian gunnery was bad." I should have accepted it perhaps had it stood thus: "It was known that the Italians placed so little reliance on the use of their new guns that they neglected to exercise them, and the badness of their practice was manifested in two days continuous firing on the forts of Lissa, *therefore* this must be taken into account with after occurrences." The argument thus stated, I have looked for in vain, but have met instead with the statement that the Italians placed extraordinary reliance on their guns, and that, as I have said, the question of "guns *versus* rams," was one debated, and quite settled in favour of the former by the Italian officers. I also know that a sufficient impression had been made on the Lissa forts to raise hopes of their capture. These things bring to my mind the question—"Allowing the gunnery of the Italians to have been somewhat deficient, could it by approaching perfection have stopped these unruly Austrians in their career?" Then there arises another point. The Italians were not armed entirely with plate-piercing guns, so that should we decide that they *could not*, even with perfect gunnery drill, have stopped the Austrians, it may still be argued that they would have succeeded, had they been completely armed as the "Bellerophon" or any of our most modern types of war ships. It becomes therefore better on the whole, that we should leave the actual, and come to the hypothetical, in order to draw our lesson.

The question to be argued is this, Can you, with a fleet of Bellerophons and the most highly-trained gunners, being in the position of the Italian fleet, stop another fleet of Bellerophons coming down upon you in the position and with the intentions of the Austrian fleets, by means of your artillery fire? This is the great question which the battle of Lissa calls upon us to decide. Perhaps none of us are aware of the extraordinary importance of a right decision and a speedy one. To my mind, it enters—shall I say as an *intrusion*?—into all our schemes of construction and armament, and raises uncomfortable doubts which I should only be too glad to put aside, but not being able to do so, must come here to share with my hearers, or to have them put aside for me.

Let us just reflect a little what the consequences may be, should it turn out that what I asserted in my former paper, and what Lissa confirmed, is actually the truth? Namely, "that the serious part of a naval attack is not the guns, but the rams." The very least harm which can come to us, is another of those expensive reconstructions of which we have had enough experience, while the limit of inconvenience is drawn sufficiently wide to include any amount of dis-

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aster in the first naval war, through dependence on a weapon whose day is past. There is no ship in the English navy built or fitted on the understanding that her guns are to perform a subordinate part in her offensive operations, but there are suggestive models to be seen here and there, which may warn us of what is possible, supposing this great question of rams *versus* guns, should be settled by practical experiment in favour of the former.

Before entering on our specific examination of what may be predicated of the meeting of our two hypothetical fleets, let me just put some general considerations before you, which I have nowhere seen commented on, but which appear to be deserving of the most careful weighing at the very outset of the question.

I have said that without other elements than the tonnage of ships, compared with the number of guns carried, the artillerist must shew that his gun can effect five times the damage on its iron target that its predecessor could on its wooden one, before he can claim to hold his own even so far. If we add rapidity of fire, as another element, we shall find it all against the guns. If we add accuracy, we find it still to depend on the accuracy of the human eye, and the steadiness of the platform, and do not thereby put much to the credit side of the guns. If we add range, we find it valueless without increased accuracy. So that the artillerist is left to prove not only that his shot *when it strikes* shall do five times the old damage, but shall add to it damage enough to make up for loss by decreased rapidity of fire. But if we bring the ram in as part of the equation, we find the gun retiring still further from its position. However we arm our ships with guns, whether on the broadside or turret principles, or on a combination thereof—one thing will remain certain, that the best position for delivering the fire, will be broadside on to the object. But if the object be an approaching ram, the best position for attack by guns. is the worst position for receiving her. Again, a ship to use her ram in the best manner, puts herself end-on to the object to be attacked. But if the object be a ship defending herself by artillery fire, this end-on position is the best for receiving it. For it is no longer as it used to be in this matter; "raking broadsides" are not now to be dreaded. A ship end-on, offers the smallest target to the enemy, and gains any advantage there may be from presenting her plates at an angle to the line of fire. She is however in the worst position for using her guns. Let us see what she gains by so depriving herself of them.

That which creates all the confusion of a naval battle, is the smoke; that part of it which most confuses any particular ship, is her own smoke—not her enemy's. If I, at the distance of a few hundred yards from my enemy, fire my own guns, I cannot for a minute or two see what my enemy is doing; at best, I have but a confused idea of it. If my enemy covers himself with the smoke of his guns, but I abstain from so covering myself, I can quite clearly make out *his* movements, while I know he must be doubtful about mine. If, therefore, I wish to run him down. I shall hope to see him envelope himself with smoke as soon as possible. If I *could* use my guns—which I cannot, being end-on to him, both to receive his shot in the safest way, and also to give him

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my stem in the speediest way—I should still not use them, because it would prevent my seeing my way clearly. Will his ship meantime do me fatal damage? We shall examine that point shortly. At present we stand thus:—He, to use his guns, places himself in the worst position and under the worst circumstances for receiving my ram. I to use my ram, place myself in the best position and under the best circumstances to receive his fire! These are very broad and simple considerations, I cannot of myself escape from their lessons by any bye-paths.

We may return now to our two fleets, one in line-of-battle, trusting in its artillery, the other in a mass, trusting to its ramming powers under full speed. Will the artillery fire stop it?

Let us say the approaching fleet steams 10 knots towards the other, and that the fire commences at 2,000 yards. With the old smooth-bore guns it used to be our naval rule that 2,000 yards was 500 outside the range of effective fire, not because of any lack of destructive effect of missiles, when they hit, at that range, but because they so seldom hit. The slight increase of accuracy due to the careful construction and lower trajectory of modern guns may have altered the old rule a little, but I think 2,000 yards will be considered the extreme effective range. But just consider further, what such a distance means? It signifies that the defending fleet has only got six minutes to defend itself in, for in six minutes, at 10 knots, the approaching fleet will crash into it! Recollect, again, what this means with modern plate-piercing guns. It means that four shot, at the very outside, can be fired from each gun, whether they hit or miss. 28 shot from a Bellerophon at the bow of another Bellerophon, with a strong probability that if those 28 shot do not stop her, there will be a crash, a few cries, a heeling over to 45°, time to fire "just this last"—which does not hit—and we and our men, guns and all, go seeking the still waters a thousand fathoms down! This is no over statement against guns, for I find the mean of 65 rounds fired from 6 and 12-ton guns at a target, for speed and accuracy, under the most favourable circumstances, was 1m. 53s. between each round.

We must remember, in considering the chances of shot hitting or missing under the circumstances given, first, that the number of misses from improper elevation greatly exceeds those due to improper direction. If this is so at a steady target, how enormously must the disproportion be increased when the distance of the target is not only doubtful in the first instance, but is altering at the rate of more than 300 yards per minute. If the first shot were fired, as we have supposed, at 2,000 yards, the next would be at 1,500, the third at 1,000, and the fourth at 500. The elevations would commence at 4° 30′, and would descend to 3° 15′, 2° 6′, and 1° 0′. Now if the rate of firing at a target whose distance is known and fixed be only one round in a minute and a half, is it an exaggerated estimate to say that the above circumstance will reduce it to one round in three minutes? Of course I speak of shot where some attempt is made to hit the object. Then with these two rounds per gun, instead of four, which could really be fired with any prospect of result, I must leave it to you to say, what

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proportion you think will take effect. I have no means of calculating it, and I am not aware that any experiments have ever been tried to determine this most important question.

But so far as Lissa's lesson goes, I am quite confident that the best of gunnery on the part of the Italians would still have called forth those expressions of surprise from the Austrian officers at their immunity from danger. Those, however, who may take an opposite view, will certainly agree with me that we should ascertain with all speed, by experiments, what are our real chances of hitting an enemy who is altering his distance at so rapid a rate. The practice might easily be carried out with any ship which fires nearly in the line of keel, by running directly for a target at full speed, firing at it as rapidly as possible, and noting the results from the masthead.

In 1862, the effect of this connection of rapid motion with gun practice was commented on in a very able and practical little pamphlet, by Lieutenant Duncan Stewart. He says, speaking of some experiments of Admiral Martin in 1861, "I must confess I was greatly astonished " to find how few shots could be got at a ship whilst passing the one " I was in. It must be taken into consideration that there was no " smoke to intercept a clear view of the other ships—that there was no " firing upon the ship I was in, and consequently no confusion—that, in " short, everything was in our favour; yet so difficult did I find it for " captains of guns to get a shot in close action, that I am forced to doubt " whether it would not be advantageous to discontinue the practice of " extreme training, except at very long distances, and leave it to the " helm to keep the object within easy training of the guns pointed " abeam.

" A still greater difficulty than training arises from the rapid altera- " tion of distance, and the consequent increase or decrease of eleva- " tion which the gun requires. . . . . Let us suppose two ships " approaching one another at the rate of 10 knots each—that is, " diminishing their distance at the rate of 20 knots, or a knot in three " minutes. The two ships being a knot apart, would, in three minutes, " be into one another, if they so wished. The gunnery-book recom- " mends that fire should not be opened, from the old or unrifled guns, at " a greater distance than 1,500 yards; therefore, in 2½ minutes, the " maximum distance recommended for firing would be traversed; and " this necessitates a progressive alteration in the elevation of 3½° " or ¼° for every 100 yards. Now let it be borne in mind, that this " rapid change of distance has to be calculated by the eye, and " allowed for by each captain of a gun. It must be obvious to any " one, who knows anything of the state of a man-of-war's quarters, " that the distance of the enemy could not be communicated verbally " from the deck, so rapidly as to make the information available for " practice."

Now, taking all these considerations, general and particular, into view, I cannot escape from the conviction that our question,—"Can " the fleet, using its artillery, stop the other fleet proposing to ram at " full speed?"—must be answered with a most decided negative. I do not say that the action of Lissa proves it—but I do say that that

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action brings to the surface, and forces us to argue out those questions which do prove it.

So far, then, I have no hesitation in saying that the break up of the Italian fleet, and the speedy establishment of the *mêlée* while yet the Austrians were comparatively untouched, were the natural results of the positions and ideas of the two fleets. The inefficient gunnery of the Italians, is beside the question.

So much for the causes which enabled the Austrian fleet to divide the Italian, and place itself unharmed in the interval. Now for the strategic effects of such an occurrence.

When the enemy's line was so broken in olden days, the attacker could concentrate his force on the weathermost ships without a chance of those to leeward getting up in time to save them. Steam has abolished this advantage to the extent that there are no physical obstacles to prevent the re-union of the divided fleet. We must not, however, imagine that dividing a steam fleet in two, is without strategic value, the moral effect of a few ships finding themselves suddenly cut off from their main body, and apparently surrounded by a superior force, will, generally, be great enough to induce an amount of hesitation and doubt in the minds of the officers commanding such ships, sufficient to make a considerable moral obstacle to re-union. We must never lose sight of the fact that humanity is made of such stuff, as rarely to be capable of acting well when the leader is suddenly withdrawn. And, if you can cut a few ships off from their Admiral, the mere fact of your so separating them, is many points to their loss and your gain. They are quite sure to be more undecided in their movements, more unsteady in their fire, and altogether more at your mercy, than if not so cut off. There are very few officers who know exactly what to do, and do it, when in times of excitement like a naval battle, an unexpected occurrence places them at an apparent disadvantage. Nelson, certainly, was not to be so foiled, but it was the very rarity of that quality which made it so marked in him. But neither is the Admiral who is cut off from his ships in a happy state, he may be quite ready to take the best steps possible under the circumstances, but he can have no confidence in being seconded by the cut-off ships, so that the strategic effects of breaking the line, are not to be despised even with steam.

But now, if the Italian fleet could not stop the Austrians, by their fire, under any circumstances, what steps should they have taken? This is the important question, which has not received any answer, but which I believe can be answered with thought. It involves however, the remedy, and Lissa only shews us, the disease; therefore, I do not propose at present to attempt the consideration of *that* lesson.

From what happened after the two fleets fell into confusion, until they separated, two incidents only, need be drawn forth for remark—the sinking of the "Re d'Italia," and the firing of the "Palestro." After several failures, partial rubs, and total misses, one Austrian ship —the "Ferdinand Max"—sees ahead of her a grey mass, she goes full speed at it and hits it fair. The shock to her, does not appear heavy

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and does no damage; the huge grey mass, however, surges over 45°. The "Max" backs astern, and looks with somewhat of awful curiosity for the result of her blow. It is not long doubtful. The "Re d' Italia" tumbles back again. There is terrible confusion on board, for the water is roaring into her like a cataract. In two or three minutes the victim plunges heavily down, and leaves nothing to tell of her whereabouts, but a few shrieking, struggling remnants of her ill-fated crew of 600 men. 400 souls, they say, went with her to the bottom. Now, what lesson are we to draw here? simply that there is an end to the danger previously supposed to be incurred by the ram in striking. The "Max" ran her prow completely into the "Re d' Italia"—as shown in figure 3, where the lines represent the marks found on it after the battle—without any evil results whatever. There was no displacement or straining of her engines, nothing in short as a set-off against the terrible damage she inflicted. The power of the new weapon was conclusively proved, and it is henceforth impossible to doubt its practical value.

The lesson to be drawn from the firing of the "Palestro," may be viewed in two lights. First, it shews the necessity of getting rid as much as possible of all combustible materials in a man-of-war. Next, it proves the enormous importance of proper appliances for promptly extinguishing fire during action. The writer in the *Revue des deux Mondes* holds that the "Palestro's" disaster is absolutely condemnatory of partial plating. Agreeing in this view, I do not shut my eyes to the fact that plating can no longer keep out shells. But it must be remembered that though it cannot keep them out when they hit fair, it can reduce materially the chances of their hitting at all; for it necessitates heavy guns and few, in place of light guns and many. It is enough for us to know that the "Palestro's" death blow may have come from an Austrian wooden ship, and that such a blow would have been harmless had she been fully plated.

There is a suggestive lesson to be drawn from the fact, that after perhaps an hour and a half confused *mêlée*, the opposing fleets had passed through each other and re-formed, the Austrians being now in the position previously held by the Italians. Part of this result was doubtless due to the desire of covering Lissa, but I think it was also due to the power of movement preserved intact, and the natural instinct of concerted action, rather than independent combat. The Austrian charge placed most of their ships to the eastward of the Italian fleet at the first onset, and both fleets seem simply to have re-formed where they found themselves already massed.

We heard a great deal of the extent to which signals were used on both sides, when the early news of the battle reached us. I am inclined to think that signalling did not bear a very important part in this battle. There were, undoubtedly, a good many signals made on both sides, but mostly before and after the *mêlée*. There is no occasion for us on this ground to underrate the importance of signalling. I think that Lissa shows the value of concerted movement, and efficient signals are the only means of securing it.

It will be seen from what I have said, that I find myself obliged for

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the present to hold that the gun, as a naval weapon, no longer keeps the first place. In my previous paper on "Tactics," I drew such a conclusion, but I was not then aware that the case is nearly so strong as it now appears to me. The *Revue des deux Mondes* does not support me in this view, but considers Tegethof had "an unheard-of "piece of luck, of which he knew how to avail himself. In spite of the "incontestable power of the ram, the gun still remains the chief arm, "and rules Naval Warfare." Admiral Touchard however has no doubt about the matter. "The beak," he says, "is now the principal "weapon in Naval Combats—the ultima ratio of maritime war."

Now, I think to speak of Tegethof's as an "unheard-of" chance is an utterance without basis. It was the first time the experiment of ramming had ever been made in the open sea. It broke up the Italian fleet to commence with, and it destroyed their finest ship in a few minutes; it won the battle, and yet was only an unheard-of chance!

Do not let us be led away by such an assertion. Let us carefully separate fact from opinion—remember that the latter goes to the winds before the former. How does the case stand? General opinion—even of the Austrians themselves—says, "Oh, ramming is such uncertain work, it can seldom succeed." Fact says it is so far uncertain that it wins the first battle where it is tried, it also says that, in the first six months of 1866, 1,924 ships were reported at Lloyds as having rammed each other to such an extent that 92 of them found it convenient to go to the bottom without further parley. And these nearly 2,000 ships which so succeeded in doing this difficult thing were all of them trying "how not to do it." Besides, who *knows* it is a difficult thing? Who has tried it and failed often enough to certify to its difficulty? The answer is, no one. There is a general opinion that is difficult in the teeth of the well-known difficulty of preventing it. The real fact I believe to be, that the "wish is father to the thought" in this matter. The consequences of the change of weapons are so revolutionary, that we decline to entertain the idea, and will do so till it is rudely shaken into us.

Admiral Touchard, comparing the attack by rams to a bayonet charge, believes, that such comparison holds throughout, and that the battle, commenced by artillery will be terminated by rams. I take exactly the opposite view. The bayonet charge resembles the attack by rams, more nearly in its moral, than in its physical effect. The nerve-disturbance effected by the rapid approach of a line of sharp pointed glittering steel is so great that, as we all know, its advent is seldom waited for. The opposing forces gaze for a moment, and break to fly for their lives. How the enemy's nerves will stand the rush of a line of rams at 10 knots, let those who have either been run down at sea, or have just escaped it, answer. But the bayonet charge only finishes an action on shore, because it cannot begin it. It cannot be delivered till the forces have pressed closely on one another, as a man can only run a certain distance before exhaustion takes place, and because the nature of the ground usually prevents it. Neither of these circumstances affect the sea-bayonet charge, and few who mean to win,

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will hesitate to commence operations by at any rate disturbing the nerves of their opponents.

Let us also seriously reflect on the terrible moral effect of the sinking of a ship like the "Re d'Italia?" When the two fleets drew apart, Persano counted his ships. "Where is the 'Re d'Italia?'" he asked by signal. "Sunk!" flew at the mast-heads of several ships, as answer. Sunk! the ship he had left a couple of hours before. Sunk! his finest ship and 600 men! With no premonitory symptoms, no grandeur of fire and smoke like the "Palestro," then in flames. Only lying quietly at the bottom of the Adriatic, full of drowned men at their quarters, and an Austrian Fleet not far distant in perfect order, ready to send one or two more down to keep her company if need be.

Victory is gained, not by extermination of men or destruction of material; but by a moral effect produced on the minds of the survivors. In a fleet in action, the destruction of life in the interior of one ship by shot, has no moral effect on her neighbours, simply because they are ignorant of it. But send her to the bottom, or blow her up, and the effect thrills through every nerve—a matter of exultation to the winners, and of depression to the losers. As regards gaining the day, there can be no question, that the destruction of life by shot spread over the whole fleet, bears a very minor relation in the attainment of victory to the destruction of one complete ship and all that she contains. I think it must be remembered too, that capture has all but disappeared as an element of naval warfare. In the days of sailing vessels, when capture was imminent, flight was impossible. But now a ship will fly from the scene of action as a first measure, and will only haul down her colours if caught up afterwards.

I must now conclude this outline of the lessons which I imagine may be drawn from Lissa. No one can be more conscious of its many faults than I am myself. A strong conviction that the battle was a premonitory symptom of an extraordinary revolution in naval warfare near at hand—a conviction which grew as I sought to weaken it—made it almost a matter of duty on my part to put it into words. I have endeavoured to confine myself to indicating the causes which will produce these revolutionary effects. I may at some future time ask you to look closer still into the question, and indicate the measures I conceive will be necessary in order to be prepared for so great a change.

Shall I be deemed fanciful, if I mention finally some straws which are indications to me how the wind blows in the matter of guns *versus* rams? During my naval career, more wonderful changes have passed over the Service than have occurred during any other equal period of time. All these changes have been attended by one extraordinary characteristic. They had no sooner reached perfection than their death-warrant was signed! When I entered the service, the Naval world was wholly occupied by the great Symondite question. Sailing frigates, and their wonderful powers under competitive trials, experimental brigs, cruised in company, and attracted universal admiration by their completeness and perfection. But lo! no sooner was everyone satisfied that in the frigate and the brig we had really reached per-

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fection, than a rumour began to spread that few more would be built, because the paddle frigate and sloop were the true "eyes of the Fleet." Then came the great question of the paddle frigate, which was no sooner solved by Terribles, Sidons, Retributions and Odins, than it became noised abroad that the screw was the true mode of propulsion. Then came the complete reconstruction of the Navy on the screw wooden-ships' principle, which turned out those magnificent specimens of naval architecture which we should be very glad to be well rid of at this moment. Then rose our iron-clad fleet, which is as yet so far from perfection that we need not fear for its stability. But if our ships have not reached that dangerous precipice, have we not reached it with our guns? Their wonderful powers, the perfection of the appliances for working them, are the admiration of the world. Having made little progress for centuries, they have suddenly jumped to a position undreamt of ten years ago. I hear them on all sides, and for the first time, spoken of in language and in terms such as I have heard used towards sailing frigates, brigs, paddle steamers, and screw line-of-battle ships. I remember that when the talk and controversy about sailing-vessels ran highest and hottest, there was a doubtful under-current pushing up Terribles, Sidons, and Retributions, which ultimately swallowed up the discussions and sailing frigates together. Then waxed the Service-talk strong on the subject of future Naval actions being fought by sailing line-of-battle ships, each with her attendant paddle steamer. The best means of taking in tow and casting off, and the rate of towing, were the great questions argued. A very small minority had seen in the "Rattler," and later in the "Amphion" and "Arrogant," an end of these questions through the near-at hand rise of the screw; but the mind of the Service generally was not at all turned in that direction, and even after the "Blenheim," a line-of-battle ship had, to the wonder of Portsmouth, *steamed* out of harbour, men still ridiculed the idea of a complete steam fleet. Then, opinion having tardily admitted that it was conquered by fact, we were building our finest specimens of wooden men-of-war, when a minority in the shape of a French Emperor discovered that the means of attack were terribly in advance of the means of defence in ships. "La Gloire" had her momentous birth—whose results are by no means ascertained—and her brethren and sisters are springing up in every direction. There is, as there always has been, in these changes, something like a nervous clutching of opinion—a sort of drowning-clutch I may say—at the idea of a restoration of at least a part of our wooden fleet. This we are prepared for, for we have always seen it. But when I look for the under-current pushing up the new thing, I find little distinction in the matter of build, little in the matter of propulsion, but I notice a confused buzzing about a new weapon—a certain half-hearted arming, sharpening and pointing of the stems of ships. Thinking over the matter, I observe that this stem-weapon is in a measure antagonistic to the other one—artillery. That at least, the ship fitted and handled best for one, will be fitted and handled worst for the other. *Am I* fanciful, if with my historical parallels hovering about me, I

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further observe the gun question at its height, and see the precipice at hand?

Commander DAWSON, R.N.: As a gunnery officer, I suppose I ought to stand up for the guns. I am quite shocked to hear Captain Colomb, a gunnery officer himself, stand up and abuse the guns. With regard to the ram, I am not quite prepared to accept the doctrine that the ram is the new weapon of future war. There was a weapon which I expected Captain Colomb would have alluded to, and which I think will come to replace the ram in another generation. There is one thing observable in the action at Lissa, that though there was a determined attempt to ram on the part of several, if not of all the iron-clad ships on the Austrian side, yet there was only one successful result. I think that points to the fact of there being a great difficulty in hitting a ship; that, although the Italian iron-clads do present their broadsides to the enemy in the line ahead in the diagram, yet by a turn of the helm, they might prevent collision, or at least receive the shock in a better position than on their broadside. I think the ram question is open to great discussion; but I think, if you could introduce a system that would destroy by a graze instead of by ramming, it would be a more simple operation. Another point Captain Colomb deals with is, whether the Admiral should occupy a position in the line of formation, or whether he should be separated from it. I should have thought if there were one thing the "lessons from Lissa" have taught us, it is that the Admiral ought to be leading his fleet. I think the Austrians gained their success chiefly by Admiral Tegethoff being in the centre of his own fleet, and leading them by his own example. And I think the Italians may be said almost to have lost the battle because the Admiral was not where he ought to have been, in the centre of his fleet on that occasion. As far as the "lessons from Lissa" are concerned, that is one lesson, I think, we learn from them. What Captain Colomb says, with reference to the uncertainty of hitting a moving object, is, I think, undeniable, not only with reference to the motion of the vessel which is firing, but also with reference to the moving vessel aimed at. Most of our experience in gunnery has been confined to firing with very little motion; that is to say, with very little speed. We fire with rolling motion, but very rarely whilst turning rapidly, or moving with great speed. We seldom fire at a moving object. When I was serving at Plymouth, Captain Jerningham made some experiments in firing at a target in tow of a gun-boat going at full speed, and the result showed the difficulty of hitting an object which is going at considerable speed across the range. Evidently, if you are altering the range, and altering the direction of your vessel at the same time, it must be extremely difficult to make any accurate practice with guns. We must come to some more short and decisive weapon like the ram, if you can hit with it; but if you cannot hit with it, I should like to have some implement by which the enemy can be destroyed by a simple graze of your own ship.

Captain COLOMB: I presume Captain Dawson suggests that I ought to have mentioned the torpedo, which is the pet at present. But he should understand that I have been treating of "the lessons from Lissa." The torpedo was not used at Lissa. It comes only under the head of "remedy;" and I have been pointing out the "disease." If I come to treat of the remedy, I should certainly not fail to avail myself of such information as I can get from Captain Dawson on the subject. I may mention this, that when I, unfortunately, found myself deserting my old colours in the matter of guns, (which was a very unpleasant process to me,) I came, as a last resource, to the conclusion, that guns would be still the most important weapon in the attack on fortifications, even if we could not use them so much as we could wish against ships. Then some information conveyed to me by Captain Dawson drove that idea away, because I am quite unable to believe, on account of the extent to which the science of the torpedo is being carried, that our ships will ever be allowed to come near enough to destroy fortifications.

Commander DAWSON: The Italian fleet were kept out of Venice by the knowledge that stationary torpedoes were planted between the batteries.

Captain COLOMB: I think there can be no question about that: therefore, that is another point where the ground is cut away from under the guns in a very distinct manner. With regard to the Admiral leading his fleet, we must not mix

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up two questions. There is the question whether the Admiral is better employed as part of his formation, or as not a part of it. The position that the Admiral may afterwards take up, is quite a different matter. I am not prepared to say that the Admiral should not on occasions lead his fleet in. But I think, if my anticipations are right, that a great deal of movement, and a great deal of combined movement, and a great many repetitions of what we saw in the Austrian and Italian fleets—that is, much passing and re-passing through the fleets should be a feature in future actions—I think it will be extremely desirable that the Admiral should not be part of his formation, not the pivot upon which his fleet is to turn. I think he would be better away from the formation. But what his position may be is quite another question.

The CHAIRMAN: I am sure the meeting will join me in giving our best thanks to Captain Colomb for a most interesting paper, a paper that gives one a great deal to think of for the future, as well as interest in the action at Lissa. There are one or two points I think we may touch upon in our remarks. First, I should like, if I may be personal myself, to set him right on one point he mentioned with regard to the battle of Navarino. I think he said there were not sufficient general preparations. Curiously enough, it was a battle in which there were more preparations than usual, inasmuch as it involved the question of preparation for peaceable reception and also preparation for possible war. The line was clearly marked out for a peaceable line going in. But at the same time for war there was every preparation made that the Admiral could possibly make, for the guidance not only of his own ship, but of every ship in his own squadron, every ship in the French squadron, and every ship in the Russian squadron. Singularly enough, every ship was furnished with a plan not only of the harbour, but of her own position marked out in it, and of the position of every other ship in the squadron; and not only of the allied squadron, but of the enemy's squadron. So it is very clear there was a great deal of preparation made there. Every ship went in with a full knowledge of the plan. I pass over this, having been personally concerned in it. I now come to remark upon one or two points. First of all with regard to the future position of the Admiral in the squadron. It is a very difficult thing to say which way it is to be. We have all a recollection of English history, of the way in which a British Admiral went into action, shifting his flag from one ship to another. In one action we read of this being done three times. Again, in later times, we have seen that an Admiral has shifted his flag, and has been enabled to superintend the action of his squadrons in two separate parts, a little apart from each other, better than he would have done if he had been all the time in one ship. But that was an action where those two separate parts were fixed, in action against forts. It would be hard to define a general rule to apply to all circumstances for an Admiral in action. One thing is perfectly clear, that wherever he may be, he should be in a position not only to make signals to his squadron, but also to show a good example to the whole of his squadron. The tactics of the Austrians and the Italians are open to various opinions. It is a very curious thing which we must remark upon, that only one ship was rammed out of all that fine charge. The loss of the other vessel was a matter of gunnery. Gunnery did one, and ramming did the other. It is curious that with the utmost intention on the part of those seven Austrian iron-clads, there was only one successful case of ramming. I am not surprised at it when they were in motion; but I am surprised at it afterwards, when they were in *mêlée*, that there was no opportunity given for the ramming ships when they were brought to a standstill. It appears to me that the most dangerous time for a ship is solely, when she stops, because, immediately when she stops after ramming another vessel, another ship can ram her and run her down. It would be difficult to make any tactics in a *mêlée;* and I think we must fall back upon what is analogous to the spirit of the service in our Navy, which I hope will long continue, namely, that every individual Captain should place himself in the spirit of his Admiral, and should be taught that he cannot do wrong if he goes right at an enemy's ship. He must be under certain general rules. If it were impossible before, to make signals very frequently in action, it would be much more impossible in the present day. We move far too quickly now. The vital blows of a battle will be given, comparatively, in a few minutes. There is no time for signals. Who that has ever seen a

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squadron steaming along, and has known the difficulty of making out signals when there is no firing going on, can doubt the great difficulty of signals when an action begins? I must say the instructions of the Admiral should be given before the action is begun. His policy and the way the enemy shall be received should be settled beforehand; his Captains should all thoroughly know what his wishes are; and what they are to do in such and such circumstances, and without waiting for signals to put them into operation. There will be no time for making signals, whether the Admiral is in a swift steamer going about, or whether he is on board one of the squadron. There is no time for signals in a *mêlée*, and it is the *mêlée* which decides the battle. As to shifting the Admiral's flag, we must remember that this very unfortunate ship that was rammed at Lissa was the Admiral's ship, and the squadron might have suffered the discouragement of seeing their Admiral go down. So we cannot make a rule as to the way in which the Admiral should act. It strikes me as a very curious thing that, after the Austrians had passed, the Italians did not, if they possessed the same intention, ram the Austrians, exactly as the Austrians had rammed them. Looking at the matter, without any attempt to form any plan of tactics, I should think nothing could be worse than an extended line. I would rather see the squadrons in two divisions, a little apart from each other; and whichever division the enemy selected to attack, the other division should run into the attackers. These are crude ideas thrown out at the moment. We must think the subject over a good deal before we make any positive plan. I do not know anything that is more liable to be overturned, than any theory we can form of battles on general principles. One thing will last for ever; that close action, be it with our rams, or whatever it may be, is a system we must make up our minds to, as a thing more consistent with our English character, and more suited to it, than fighting at long range.

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The Journal

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Evening Meeting.

Monday, March 4th, 1867.

REAR-ADMIRAL SIR F. W. E. NICOLSON, Bart., C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between February 4th and March 4th, 1867.

ANNUAL.

Cooper, Egbert Wm., Lieut. 2nd W. I. Regiment. 1*l.*
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THE ATLANTIC TELEGRAPH CABLES OF 1857-8, ALSO OF 1865-6.

By Staff-Commander H. A. MORIARTY, R.N., C.B.

(Read by the Secretary.)

UPON being requested to contribute a paper upon telegraph cables, I felt as much at a loss how or where to begin, as if I had been asked

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to write a treatise on a ship, not knowing whether to commence with her construction from the keel upwards, or to take her at once, fully equipped, into a gale of wind and a raging sea. In point of qualification also the analogy holds good, for although I have lived 35 years in ships, I do not know how to build one; neither am I a civil engineer or electrician; nor is it anticipated that this paper will be heard or read by an electrician, or civil engineer who has been engaged in telegraphy, as it cannot be expected that either will derive any information therefrom. My aim is merely to give to members of the sister services an outline of what has been done.

The progress of telegraphy since the first practical application of the influence which a galvanic current exerts when passing a magnetic needle, has been very rapid. Messrs. Cooke & Wheatstone arranged an electric telegraph in 1837. The first established successfully, and worked for a useful purpose in this country, was that on the Blackwall Railway, in 1842. About that time a proposition was made to the Admiralty for running a wire to Portsmouth, but so little was the new discovery relied on, that their Lordships decided upon having no other telegraph than the chain of semaphores then established. Nor can it be much wondered at, for between the peace of 1815 and that time, the unemployed officers of the Navy were as much occupied in discovering new telegraphs as other mechanical geniuses had been in discovering perpetual motion. As the Blackwall Railway was worked by an endless rope, the use of the telegraph was imperatively necessary. Even the ordinary railways, with the double line of rails, could not be worked safely without some such rapid mode of communication. Thus the railways became the foster-fathers of the electric telegraphs, but principally for their own business. As it was impossible to establish telegraphic communication across either of the channels without an effectual insulator, Dr. Montgomerie came to its aid in 1848, by publishing his valuable discoveries connected with the properties and uses of gutta-percha. It was not till 1851 that the bold project was carried into effect of laying a stout and strong cable from Dover to Calais, 23½ nautical miles in length, containing four separate conductors in one core; that line has given very little trouble since it was laid. Though two years elapsed before another attempt was made—in that from Dover to Ostend, 70 nautical miles in length—no less than 55 submarine cables have now been successfully laid by one company alone, not including the Atlantic cables. The cores of these 57 cables were made at the gutta-percha works in the City Road; a few more have been made by other companies. Of the 55 cables above mentioned, two only exceed 1,000 miles, that from Malta to Alexandria (1,351 nautical miles), and that down the Persian Gulf (1,276 nautical miles); both have the distance broken by being landed at intermediate stations. As the former cable has given much trouble, in consequence of passing over reefs in the comparatively shallow water of 40 fathoms or less, I believe it will be remedied either by replacing it by degrees with stronger cable, or by giving up the African stations and carrying a direct line, in deep water, from Malta to Alexandria.

Before passing from the comparatively small distances to the once

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great problem of connecting the two hemispheres, it may be as well to premise that the experience acquired by these scientific men who had the responsibility of laying and maintaining those cables, induced them to believe that a very strong cable was necessary, while the opinions of some respected philosophers was against the attempt to cross the broad ocean, as they considered that the electric current could be of no practical utility beyond limited distances. Professor Sir W. Thomson, Sir Charles Bright, Mr. Whitehouse, Professor Wheatstone, Mr. Varley, Mr. Latimer Clark, and others firmly maintained the opinion which has been proved to be correct.

After the successful working of 12 or 14 minor lines, including the first (Dover to Calais), for five years only, and the longest (Italy to Corsica), of only 95·6 nautical miles, some bold projectors conceived the idea of forming a company to connect Europe with America; and the Atlantic Telegraph Company was established in 1856, or within five years of the effectual connection between England and France. Mr. Brett, Mr. Cyrus Field, Sir Charles Bright, and Mr. Whitehouse were the prime movers in what appeared to the majority of our countrymen as a wild and impracticable scheme. However, the company was formed, and £350,000 raised from among a few wealthy enterprising men, the shares being £1,000 each. The Governments of Great Britain and America encouraged the attempt by each offering a large annual subsidy as long as communication was maintained, while the North American provinces and the United States granted concessions to Mr. Cyrus Field, assuring him the sole right of laying telegraphic cables from any part of the United Kingdom to any of the opposite coasts, till south of the State of Maine. France also joined in this protective licence, which was to have terminated in March 1867, if telegraphic communication were not previously established. The British and American Governments also lent ships deemed suitable to carry the first cable, and for the purpose of escort. Mr. (now Sir Charles) Bright was appointed engineer-in-chief, and Mr. Whitehouse chief electrician.

The core of the first, as well as all subsequent cables, was made at the gutta-percha works in the City Road, and then removed in lengths of one mile each to the works at East Greenwich and Birkenhead, where it was covered with hemp and iron wire. The conductor of this cable consisted of seven copper wires, weighing 107 lbs. per nautical mile. The insulator was composed of three distinct coatings of gutta-percha, weighing 261 lbs. per nautical mile; this was again covered with hemp, saturated with a tarry mixture, hove taut round it, in order to increase the size and make a soft padding for the outer sheathing of iron wires to rest upon; the latter coating consisted of 18 strands, of seven wires each, No. 22½ gauge. Therefore each mile of cable contained more than seven miles of copper wire, and 126 miles of iron wire, not including that taken up by the twist. Finally, this admirably constructed little cable was passed through a trough containing a hot compound of wax, tallow, and tar, which gave it a thick preservative coating. It was thus completed at a cost of £96 to £98 per statute mile; the weight of that length being one ton. Its specific

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gravity, 2·95; weight of a nautical mile in water, 15 cwt.; diameter, 0·637 of an inch; and breaking strain, 73 cwt. The time required for signal to pass through 2,000 nautical miles of this cable was 2½ seconds. The shore end was protected by 12 large iron wires, which made it 4¼ inches in circumference, and it weighed 8 tons per statute mile.

Shortly after the failure of 1857 (when 334 miles were laid from the Niagara), a very important discovery was made with regard to the conductivity of copper-wire, namely, that one specimen of the same size and appearance as another, would conduct the electric current 40 per cent. better. The cause of this difference depends partly on the purity of the metal, but the entire cause I believe to be yet unknown. The knowledge of this fact is taken advantage of practically, by testing every coil of wire which is taken to the works, against a piece which has been selected as a standard; and failing that point of perfection, it is rejected.

Mr. Willoughby Smith has kindly explained to me that the test is made by what is called Wheatstone's bridge, which is in this manner: the standard piece of determined length and weight (100 inches) is stretched across the table, the ends being made to connect with opposite poles of a small battery. The piece of wire under test, being precisely the same weight per length (but not cut), is brought to the same connections: a delicate galvanometer, of a few grains only in weight, is placed between them. If the wires possess equal conductivity, the galvanometer will not be affected by the divided current; but should one wire be superior, the current on that side will disturb the small magnet, in which case the piece under test must be shortened or lengthened till equilibrium is established, when, being carefully measured, for every inch it is more or less than a hundred, it will be one per cent. superior or inferior to the standard.

There is every reason to be satisfied with the conductivity and insulation of the present Atlantic cables, as a distinct signal can be transmitted in about ·2 of a second. The highest estimate I have seen, which includes the time required for a practiced eye to perceive it, is ·315 of a second, which is equal to 5,960 miles per second, or the circumference of globe—21,600 nautical miles—in 3¼ seconds. Messages are now transmitted through either cable at the rate of 12 or 14 words a minute, and no doubt will be sent still faster when required. The mirror galvanometer is now used for receiving the signals. This instrument consists of a magnet half an inch in length (carrying a mirror one-third of an inch in diameter, cemented to one end), suspended by a fibre of unspun silk, in the centre of a coil of insulated copper-wire; outside of which is placed a powerful bent magnet, which governs its position when uninfluenced by the electric current passing through the coil. Sir W. Thomson has had magnets and mirrors combined, weighing less than a grain, but those in general use weigh about 3½ grains. The spot of light is thrown both right and left on Steinheil's system, the same as that generally used at railway stations: to the right signifies a dot, and to the left a dash, of Morse's code.

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Before describing the cables of 1865 and 1866, it may be well to say a few words upon the financial difficulties encountered and overcome by the projectors. The £350,000 first raised, and the subsequent issue of £70,000, were entirely absorbed by the efforts made in 1857 and 1858; hope was almost extinguished, except in a few indomitable minds, till the spring of 1865, when £600,000 was raised upon 8 per cent. preference shares. After the temporary failure of that year, many of the gentlemen best acquainted with the circumstances were more sanguine than ever; but the difficulty of raising more money had also increased. An attempt was made to issue 12 per cent. first preference shares, but that was pronounced to be illegal. Therefore it was devised to form a new and distinct company; for though the directors had not power to issue new preference shares, they could employ the new company to complete the work upon still more advantageous conditions. Consequently, a few gentlemen met and formed the Anglo-American Telegraph Company; ten of them subscribing £10,000 each, and ten others smaller sums; the Telegraph Construction and Maintenance Company, £100,000, making a total of £230,500 at once before it was opened to the public. The whole £600,000 was subscribed in a few days, and the machinery in the City Road and at East Greenwich was again in motion night and day, preparing for a final effort. Had that failed, this generation would not have had telegraphic communication with America.

On reverting from the financiers to the civil engineers and their cable, we must also go back to the spring of 1865; we shall then find that since the failure (electrically) of the first Atlantic cable in 1858, Mr. (now Sir Samuel) Canning, Mr. Henry Clifford, with Mr. John Temple and others, under the direction of Sir Richard Glass, had been unceasingly testing the merits of every imaginary kind of cable, in order to choose that best adapted to the various requirements of a deep-sea cable. Those gentlemen commenced the investigation with minds well prepared, both by study and matured experience in ocean telegraphy. Similar ingenuity was applied to the choice and perfecting of the admirable machinery, which I will presently attempt to describe.

The cable of 1865 differed from that laid in 1858 in many important particulars. For example, the conductor was formed of the same number of wires, *i.e.* 7, but much larger; they weighed 300 lbs. per nautical mile; that of 1858 was 107 lbs. The diameter of the strand was ·14 inch. The insulation was also far superior: the conducting strand was first covered with "Chatterton's compound" applied hot, then four distinct coatings of the best gutta-percha, with a thin covering of "Chatterton's compound" between each. The entire insulator weighed 400 lbs. per nautical mile, which, with the conductor, made the entire core 700 lbs. per nautical mile: it was then ·464 of an inch in diameter, = 1·392 in circumference. The core was covered with jute as a protection, before receiving the external protecting strands, which for that cable were made of manilla, saturated with a dark preservative compound, each strand enclosing a steel wire of No. 13 gauge = ·095 inch. When thus complete its diameter was 1·07 inch, weight 35¾ cwt. per nautical mile, specific gravity 1·77,

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weight in water 14 cwt. per nautical mile, and the breaking strain 7¾ tons. The length actually shipped was 2,300 nautical miles, weighing 4,598 tons, including the two shore ends.

The cable made during the spring of 1866, differed from the above only in the outer strands, which were of the best white manilla, enclosing homogeneous wire, No. 18 gauge, galvanized, the latter being considered less liable to spring or break. The breaking strain was increased to 8$\frac{1}{10}$ tons, and the weight reduced to 81 cwt. per nautical mile, but in water it weighed ¾ cwt. more, =14¾ cwt. per nautical mile.

The Valentia shore end of 1865 had the same core as the ocean part, protected by 12 strands of No. 4 wire = 36 wires, it was 27 miles in length, and weighed 18 tons per nautical mile = 486 tons, which was sent in a separate vessel.

The Valentia shore end for 1866 was protected by 12 solid wires or rods, ·44 inch in diameter, doubly served with yarn and coated thickly with a compound of pitch, tar, and silica, under Bright and Clark's process, till the diameter of the whole cable was 2·5 inches, its weight was about 23 tons per nautical mile. The Newfoundland shore end was only 3 miles in length.

The cable of 1857 was carried by two ships; the portion for the "Agamemnon" was 1,250 statute miles, it was coiled in the main-hold, which afforded a space measuring 48 feet by 44½ feet, and 14 feet deep for the coil, in the centre of this space was placed a solid wooden cone. In the following year the size of the coil was slightly diminished and made more circular. The main-hold then received 1,129½ statute miles in 216½ flakes, the upper having 866 turns (or sheaves) each, equal to 6½ statute miles. There were also 233 statute miles on the upper deck, and 95 miles in the fore cockpit; total 1,457½ statute miles, equal to 1,265½ nautical miles. This cable was kept in a dry state. The total weight carried by the "Agamemnon," including ship's furniture, was 2,804 tons.

The cables of 1865-6 were stowed on board the "Great Eastern," in three watertight iron tanks, having vertical sides; the foremost tank was 51 feet 6 inches in diameter, the main 58 feet 6 inches, the after one 58 feet, each 20 feet 6 inches in depth.

In the foremost tank was coiled 633, in the main 817, and in the after tank 803 nautical miles. These tanks being fitted with water cocks for supply and escape, the cable was kept continually in water, as in large pickling jars, the quantity of water was estimated at 1,200 tons. The ends of the cable were carried from each tank to the testing-room and joined, so that the tests could be carried on through the whole length unceasingly, whether paying out or at rest. Flexibility and adaptation to coil easily is a great desideratum when selecting a cable, so that it be not too springy to lie flat and even, that it has not too much tar or other substance which might cause it to stick, or long fibres of hemp to entangle its adjacent part and cause it to be displaced before required.

The machinery required to govern the egress of the cable underwent several changes and modifications before arriving at the present

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state of perfection. The heavily covered cables for shallow seas, the "shore ends," &c., require a different and much stronger controlling power, than does the lighter but greater length which crosses the ocean. It is the latter only, as applied to the Atlantic cable which I will attempt to describe.

In 1858, two grooved drums or wheels were used, 6 feet 1 inch in extreme diameter, 9¼ inches wide, having four grooves, and placed 7 feet 4 inches apart, were they coupled together and attached to admirably powerful brakes (by Mr. Appold) as well as to a small engine, for the purpose of heaving back if necessary. The cable was passed round those wheels (not in a figure of 8 as in 1857) four times, there being 30 feet of cable to each turn. These sheaves or grooves increased ¼ of an inch in circumference each, in order to take up the slack caused by stretching and to prevent slipping; but in practice it was found to force that amount of stretch from the cable and break it. After the experiments made in the Bay of Biscay in June, 1858, all the grooves were made precisely similar in diameter. This arrangement of machinery is very powerful for retarding the egress of the cable, and well adapted to a uniform strain, but it has too much inertia to meet the exigencies of strains and speed ever varying; manual effort was frequently employed when the strain was slight and irregular; one remarkable instance occurred when passing the shallow water off the coast of Ireland.

The machinery employed for the same purpose in 1865-6 was very different, the principal modifications having been proposed and carried out by Mr. Henry Clifford. As the machinery of 1865 was merely strengthened and adapted to heaving in over the stern, during the spring of 1866, it will be sufficient to describe it as it was when laying the cable in the summer of the latter year.

After the cable left the fair leaders from the tank, it passed over six grooved wheels about 3 feet in diameter, each connected with a brake, wheel by the same shaft, the cable merely passed over them, there was no turn. Above each of those wheels was placed one of half the diameter, having its periphery flat and covered with an india-rubber belt; these are called "jockeys" from the fact of their riding on the cable.

Those wheels are also connected with brakes, weighted at pleasure. As each pair of wheels revolve reluctantly, according to the weights on their respective brakes, the restraining power may be made great, but the moment it exceeds the desired limit it slips through the whole of them; and any number can be put permanently out of use: usually, only 2 or 3 were in action at a time. Also the whole of the upper wheels are connected by chains to one common shaft and that to two small wheels—like steering wheels, a small motion of either will lift the whole of the "jockeys" and allow the cable to run freely—but they have no power of restraining it. The man at the foremost wheel is on the look-out that broken wires should run past freely, while the man at the after-wheel watches the dynamometer, so as to guard against any sudden strain from without.

After passing those six pairs of wheels, it had four turns round a

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smooth-faced light drum, about 6 feet in diameter, which also had brakes attached to it. This drum could be coupled quickly with strong gearing and a powerful engine, for heaving in over the stern.

Before the cable passed over the stern-sheave, it was brought by fair leads to a perfect level, and under the roller of the dynamometer, which rode as it were upon it, and, being weighted in proportion to the scale used—the pointer would indicate the exact strain. A similar instrument was used for the grapnel-rope.

A description of the dynamometer may be interesting to those who have not seen its admirable working. The roller or wheel is secured to a slide box, which is confined between smooth-faced guides, free to rise and fall vertically, while the wheel revolves on the cable, or grapnel-rope, thus bearing it down, but not retarding its progress. The slide is connected by a rod to a piston, which works freely in a cylinder filled with water, in order to steady its motions. The slide is weighted to the desired extent, thus with a strain on the rope of 60 cwt. the points of suspension being 30 feet asunder and 1,484 lbs. on the slide—including its own weight with roller, &c.—the indicator would be depressed nearly 20 inches, the cable having been drawn down 6° 18′ below the horizontal line. The proportion is $\frac{\text{Rad.} \times \text{depression}}{\text{half distance}} = \text{Tang} \angle$, and $\frac{\frac{\text{Weight}}{2} \times \text{Rad.}}{\text{Sine} \angle} = \text{Strain}$. Thus, $\frac{\text{Rad.} \times 19{\cdot}87}{180} = \text{Tang } 6° \ 18'$, and $\frac{7421\text{lbs.} \times \text{Rad.}}{\text{Sine } 6° \ 18'} = 60\frac{1}{2}$ cwt. An allowance must be made for a diminution in the distance between the points of suspension as the angle of depression increases according to the diameter of the rollers over which the rope passes. When the angle increases beyond the intended range, the weighted slide rests on its seat, simply indicating that the strain is less than the lowest figure on that scale. If necessary, the weights can be reduced to some other predetermined amount, and a corresponding scale applied. During every stage in the process of grappling, as well as when laying a cable, this auxiliary is indispensable.

The "picking-up machinery" used during the summer of 1866, consisted of two large drums, of similar diameter, with smooth faces, sufficiently broad to take four parts of the grapnel-rope. These drums were placed near the fore part of the ship, about twice their own diameter apart, controlled by strong brakes, and coupled by suitable gearing to a pair of Penn's trunk-engines when desirable. The rope did not pass round those drums in "a figure of eight," but simply round them both. A set of guide rollers between the two drums, acted upon the lower turns as they passed, shunting them into the desired positions, whether heaving in or paying out. Abaft the drums was a jockey pulley for drawing the rope off as it was hove in. On the fore side was the dynamometer, under which the rope passed before going to the fair lead over the bow.

The grapnel-rope was composed of 245 yarns of the best Manilla,

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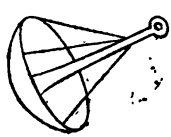
and 49 steel wires. Five yarns were laid round each of seven wires, and those twisted together formed a strand, arranged similarly to the seven wires of the conductor in the cable. Seven of those strands were again laid up in like manner, one forming the heart. The wires were of homogeneous iron or steel, of No. 13 gauge, ·095 inches in diameter, and galvanized. When complete the rope measured 2·125 in diameter, and 6·676 inches in circumference. It weighed 125·158 cwt. per nautical mile (in air), and 56·504 cwt. in water; the specific gravity being 1·823. The breaking strain was 30 tons. The "Great Eastern" carried 7½ nautical miles of this rope in one length; the "Medway" a similar piece, and the "Albany" one length of 5 miles. It was found to answer the intended purpose admirably; the only point in which improvement could be desired was that it should not unlay itself when under a heavy strain. Swivels were interposed at intervals (where most needed) after it had been used, but they are attended with inconvenience.

The principal part of the buoy-rope provided was of similar character to the above; homogeneous wire, galvanized, and manilla. There were 16 wires, No. 13 gauge. The weight per nautical mile was 43·298 cwt., and in water 18·008 cwt. Its strength was equal to 13 tons. Part of the rope for securing the "mark-buoys" contained only 9 wires, and the lower portion of each was coir, 6 inches in circumference, equal to a strain of about 3 tons. The coir rope is less liable to kink when dragged about the bottom, than the stiff heavy rope, but the lateral force of the current upon the broad rough surface was found in some instances sufficient to overcome the holding power of the anchor, causing the buoy to drift till the current became slack, when it would again take hold. There was also a chain 20 or 30 fathoms in length, attached to the anchor for each buoy.

The mushroom anchors which were used last summer weighed 2, 3, and 5 cwt. This is the only description of anchor which can be used near a cable, for fear of hooking it; and it appears possible that they could be rendered more incapable of dragging a cable, by placing four or five rods of iron from the shank to the outer edge, thus:—



which would not prevent their filling with sand and mud, or sinking in either.

The buoys were of three sizes, but similar in shape, and made of thin iron, by Brown and Lennox. The views given of them in the *Illustrated London News*, by Mr. Dudley, is better than any description which I can give. Those to be used as "mark-buoys" were 7½ feet in height, 6 feet at the base, and 6½ feet in diameter at the widest part. Each weighed 25 cwt., and was capable of supporting, besides its own weight, 1 ton 13 cwt.

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The "light-buoys" were 9½ feet high, 7 feet in diameter at the bottom, and 7 feet 8 inches at the broadest part; the weight was 30 cwt.; immersion when light, 1 foot 3 inches; when loaded with 8½ tons, 3 feet.

The buoys for grapnel-rope were 12 feet in height, 9 feet 6 inches in diameter at the bottom, and 10½ feet at the widest part. Weight, 2¼ tons. Immersion when light, 1 foot 0½ inch. Displacement when immersed to 5 feet 10 inches = 10 tons.

Each of these buoys was fitted with a stout eye at the centre of the base to receive the mooring chain, the end of which was secured by a tongue-slip at the side. "The bridle," whereby the mooring and load was transferred to the ship, was secured on the opposite side. They had also chain slings round them ready for being hoisted out or in. Each buoy carried a staff 15 or 30 feet high, surmounted by a ball and flag, by which they could be seen 6 or 8 miles; they were most conspicuous when painted dark red. These buoys were found very efficient in every respect, the result of mature calculation on the part of the civil engineers.

The choice of a ship to carry an ocean cable is a very important point. In the first place she must have capacity to stow the required length and bear the weight, especially as it is now deemed necessary to keep the whole submerged in water. The weight and space occupied by machinery is also considerable. The pitching motion does not appear to be so injurious while the cable is running out, as was originally conjectured; but it is a motion highly detrimental during repairs, or when grappling. The rolling motion of the "Agamemnon" on June 1st, 1858, disturbed the upper portion of the main coil; and a hundred miles were hauled up by hand, in order to recoil it. That might have been prevented by stowing sails or some light substance on the top: it is usual now to place a surface covering of plank, and to shore it down from the deck. The slight motion experienced in the "Great Eastern" during moderate weather, is one of her principal recommendations as a cable ship, as also the advantages derived from the employment of one large ship in preference to two smaller ones; but I believe the "Great Eastern" was enormously expensive.

When two ships are employed and they commence in the centre, as they did in 1858, they insure the great advantage of being able to choose the time, and most favourable weather for commencing, with which, in a few days, they would pass over the most dangerous part of the ocean. In 1858 the two ships paid out with great regularity; on July 30th, 10.40 a.m., "Niagara" had paid out 200 miles, and at 11 a.m., "Agamemnon" 200. August 2nd, when "Niagara" reported 750, "Agamemnon" 748½ miles. "Agamemnon" was ten minutes late with her 800, and the "Niagara" landed her end one or two hours before "Agamemnon" did hers.

That one ship should commence to pay out her half from the shore, to be joined by that in the second ship—as intended in 1857—is quite practicable under ordinary circumstances, but a heavy gale at that particular time would be hazardous to some degree, probably necessitating the slipping and buoying of the cable. If the cable is to be laid

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between two points already in telegraphic communication, it is decidedly preferable to commence from the shore, as valuable information could be exchanged between the ship and the shore she approached.

As the requirements of a cable-ship are peculiar, at no distant date it may be deemed desirable to build one or two specially for that purpose, having both strength and capacity for the enormous tanks, which would then be interwoven with the structure of the ship. As capacity and stability would be the chief requirements, that bugbear speed, which destroys the seaworthiness of so many ships, need not enter largely into the calculation. She should also be well rigged, in order to economise fuel when not laying the cable, and, with good sails at the extremities, to assist all manœuvres. I wish to express in the strongest terms possible my dissent from the present system—almost general—of sending ships to sea entirely dependent upon their steam power and their rudders; should anything happen to either, they become logs, at the mercy of the winds and waves. Masts tend to counteract the effect of the dead weight below, and prevent that quick, disagreeable rolling motion which is experienced in vessels that are undermasted, and no seaman would willingly be without sail during a gale; for my own part I would not use steam during a gale in the open sea, except under some emergency.

Among the various considerations in fitting out a cable ship, none are more important with a view to her correct steering and careful navigation, than her magnetic character and compass requirements, as in all probability she will be constructed of iron, and having to carry a cargo partly composed of the same metal, which is ever varying in quantity during the most important period; while at the same time altering her geographical position and consequent magnetic condition, the problem it will be seen, becomes somewhat complicated. It is only by careful study and a sound understanding of the principles and laws which govern such effects that their evil consequences can be obviated, commencing with a thorough knowledge of the magnetic properties of the ship herself, from the time of her launch till about to commence her voyage.

As those fundamental principles, especially with reference to the "Great Eastern," had been thoroughly investigated by Staff Commander Frederick Evans, R.N., F.R.S., they were applied in the most practical manner in the summer of 1865, to the correction of what became the principal navigating compass in the "Great Eastern." It was one of the "standard compasses" as supplied to Her Majesty's ships, and placed in a position which was both the best and most convenient that could be found; but that was only 14 feet abaft the second funnel, and 18 feet 8 inches before an iron-mast. After a few azimuths had been taken with this compass, and the deviation found to be 32° 30′ E., with her head E.N.E., and 28° 40′ W., with her head W. by N., Captain Evans, from his office, sent a single bar magnet, with directions for it to be placed 17½ inches below the centre of the compass card, with its north pole pointing 5° to starboard; with the intimation that the maximum deviation would be about 5° at the quadrantal points. The magnet

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was so placed and the deviation immediately reduced to a few minutes only at three of the cardinal points, nothing at north, and 4° to 6° was the maximum in the quadrants. Mr. Mayes (the Admiralty Superintendent of Compasses), visited the ship to make any necessary alterations, but none were required.

The magnetic influence of the ship upon the compass changed during the voyage from Sheerness towards Newfoundland, proportionally as the dip of the needle increased, and the earth's horizontal force decreased, causing changes in the deviation, as would be known to follow and might be anticipated, but by constant azimuths the changes were allowed for. That this subject is often much neglected, I can adduce no better example than that of the largest ship in the world having an iron bar placed within 2 feet of what was her principal compass, prior to this voyage. The majority of our merchant ships have compasses of an enormous size, very imposing in appearance, from the quantity of brass, boxes of chain, magnets, &c., but generally very sluggish, and inconveniently fitted for taking azimuths or bearings correctly. The choice of position with regard to the magnetic properties of the ship appear to be but seldom studied.

The process of paying out the cable has been necessarily touched upon in describing the machinery by which its egress is controlled; those points need not be repeated. The speed of the ship must be regulated according to the weight of the cable and depth of water. The shore-ends are usually very heavy, as much as 18 tons per nautical mile, but the depth of water being comparatively small, they can be laid at the rate of three or four miles an hour, with very little slack. An ocean cable which is to be laid in deep water, 2,000 fathoms, for example, and it being of similar specific gravity (1·77) to the Atlantic cable, would require considerable time to reach the bottom, and an amount of slack must be allowed, in order that it may do so without strain. A speed of 5 knots for the ship, while the cable runs out at the rate of 5½ knots, or about 10 to 14 per cent. on the distance, has been found safe and sufficiently fast.

The manner in which the cable passes from the stern of the ship to the bottom of the ocean, and how it adjusts itself there, with regard to the inequalities of the surface, and its own superabundant length, has given rise to much discussion. It appears to me impossible that it can run down uniformly in an inclined plane, and then assume a straight line at the bottom, though these suppositions have been maintained by such competent authorities, that I most reluctantly dissent from them. In the first place the cable enters the water at an angle of 10° or 12° from the horizontal, which, if continued in an uniform line, would touch the bottom at 9½ to 11⅓ miles, and a catenary curve would extend to about 15 miles; but I cannot imagine that it assumes either, for if it sank laterally, preserving the same angle there would be no means of disposing of the slack cable; but as there are from 200 to 300 fathoms surplus upon every mile run, it must dispose of itself in bends on reaching the bottom; and as considerable torsion exists at the surface, there is no doubt a little torsion towards the bottom, and those folds would be thrown uniformly towards one side. What it

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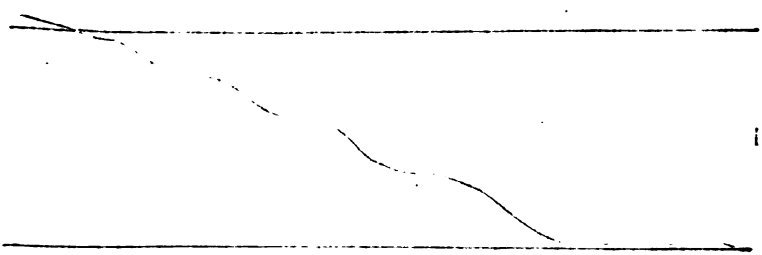
does with itself at the bottom is of minor consequence, unless when requiring to be picked up, but the manner in which it reaches that state of rest may affect its safety. When a cable is large and rough upon the surface, with low specific gravity, the friction will be great, and its motion will be softened and rendered easy of control, but the irregular and uncertain motion of a comparatively heavy cable (in point of gravity), such as that used in 1858, greatly compromises its safety. On June 29th, 1858, at 9.20 p.m., when near the centre of the Atlantic, the speed of the "Agamemnon" was reduced from 5 to 3 knots, the strain having previously been 19 to 21½ cwt., and the vertical angle 12½° to 15°, depth about 2,000 fathoms, and cable paid out 146½, to a distance of 118 miles, which is 24 per cent. of slack. For a space of ten minutes after the speed was reduced the cable continued to run out slowly, but very irregularly, giving a strain upon the dynamometer of 20½ cwt. from zero in an instant. In one of those sudden pulls which I witnessed, it broke on the stern-wheel, it was too sudden to reach the dynamometer, and certainly was not caused by the pitching or any motion of the ship. The solution I then arrived at, and still believe, is that the cable does not sink to the bottom at any uniform angle, but entering the water at 10° or 12° only from the horizontal, it sinks very slowly, till it assumes irregularities of angle or convolutions, which by bringing their length to coincide with the direction of their gravitation, they sink rapidly, forcing the upper parts to follow their section, and thus absorbing the minor folds above, increasing in size and velocity till they reach the bottom, thus:—



The impetus which those bends acquire will cause them to pull violently upon the upper part at intervals, till it has assumed a straight line. There is very little danger from this cause with a cable similar to that used in 1865 and 1866, as it has only a little more than half the specific gravity of the former, and is comparatively large and rough, the strength also being equal to a strain of 7¾ or 8 tons; the former was only 73 cwt.

The want of uniformity in the proportion of slack to the distance run from day to day, was a source of some perplexity and disappointment, when the weight upon the brake levers, the motion of the machinery, and the speed of the ship were similar to the previous day, and the observations each day supposed to be good. But immediately the existence of a varying current is admitted, the apparent

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disagreements are reconciled. For the cable is not fast to the bottom and paid out like a measuring tape, or "ground-log," but is rather comparable to the line paid out after the ordinary log-ship, which can take no cognisance of current. If the current be lateral, it will not affect the question, but should it run with the ship at the rate of half a mile an hour, it will carry her an extra 10 miles while she logs 100, and the indicator shows 116 miles of cable, which, instead of being $\frac{16}{100}$ of slack, will only be $\frac{5 \cdot 45}{100}$, or 5½ per cent. nearly. Whereas if a current of similar strength were adverse, it would produce the most unsatisfactory result at the end of 20 hours: 90 miles of distance to 116 paid out, or 28·9 per cent. of slack. Nor do I see any means of avoiding this apparent discrepancy, or of discovering it, except at comparatively long intervals of time; and if known, the only remedy would be by increasing the strain on the cable. All the cases of disagreement between the reckoning and the cable paid out which I have met, were in my opinion attributable to that cause alone. This is an important consideration, when about to pick up a cable for repair, in order to choose a place where there is much slack. It is very important that cable ships should be well furnished with patent logs, and every means of ascertaining their run correctly.

The cable itself will assist the navigator very materially by pointing out to him the amount of leeway she is making, an arc and pointer being placed over the last lead of the cable for the purpose. The angle so shewn was strictly applied as leeway, in the "Agamemnon," in 1858, and her track was very close to the great circle. It is surprising to see how little wind on the beam, or even on the quarter, will cause leeway.

The task of picking up a cable in deep water is more difficult than laying one, therefore details may probably be more interesting. In the first place the position of the lost cable must be accurately known, and unless a considerable decrease in the depth of water at some other place should cause a preference, the attempt should first be made at about four miles from the end, supposing the depth to be about 2,000 fathoms, not only for the sake of economizing cable, but it may there be raised by one or two lifts.

The first "mark-buoy" should be placed two or three miles within the end of the cable and close over it. For which purpose it is desirable that the ship should be as close as possible to the spot at 6 a.m., or when the sun is high enough for reliable observations,—if in the Atlantic, a westerly wind is preferable, as it gives a clear horizon,—by renewing those observations every hour or two till noon, and correcting her position by small runs as soon as the requirement is known, she must be very close to the spot, and also a good estimate may be formed of the drift, by the time of obtaining the meridian altitude; after which the sooner the buoy is down the better. As one or two hours may be occupied in lowering it, allowance must be made for drift. The afternoon sights will again check and correct its position, both for latitude and longitude. In case the desired accuracy cannot be insured at the first attempt, I would advise an auxiliary mark-buoy to be placed if only within three or four miles of the desired position,

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and others built, as it were from that. As the buoys in 1865 and 1866 were moored with 2½ miles of rope in two miles' depth of water they were liable to change position half a mile on either side the spot directly over the mushroom. One reason why good observers sometimes disagree considerably from each other, is that the error inherent to every sextant, through a very slight and unavoidable defect in the centring, is very seldom allowed for. The excellent work by Mr. Sims upon the sextant, is the only publication I know, wherein it is mentioned.

While mentioning some of the considerations connected with grappling, the large rope of 1866 only will be spoken of. When lowering the grapnel it is necessary to weigh it and the rope (by the dynamometer) at various depths, in order to check previous calculations and to form a practical scale for its normal condition at every depth. Last year when the depth of the sea was about 2,000 fathoms, from 2,200 to 2,300 fathoms of grapnel-rope were used, the strain while dragging was then about 8½ to 9 tons. An increase of one ton steadily, would indicate that the cable was on it. On August 17th, 1866, the bight of cable was hove 10 feet above the surface, the strain then as shewn by the dynamometer was 6½ tons, which Professor Sir William Thomson attributes entirely to the weight of two catenary curves, 4·64 of a mile each, forming an angle at the apex of 85°. The base, or space, from whence the cable had been lifted was supposed to be a little over eight miles. But it was impossible to tell the exact angle, although in sight, or the amount of slack at that particular spot, or how much the cable might slip over the soft bottom. The ship was rolling more than usual at that time, and the direction of her head was at a broad angle with the span, therefore it was strained upon the claw of the grapnel in alternate directions. The greatest strain on that occasion, with grapnel-rope and cable combined, was 11½ tons. When the grapnel was 800 fathoms from the surface with the cable on it, the dynamometer showed 7¼ tons, which would indicate a strain of nearly 4 tons on the span of the cable, which was then 1,100 or 1,200 fathoms off the bottom. On another occasion when the bight was 1,000 fathoms from the surface, the strain was 10½ tons, consequently there was a strain of six tons nearly on the cable, three tons to each part; the monster buoy rode by it for an entire week, and was only set adrift by the cable being broken (by grapnels) on either side of it. It was upon that occasion that the piece of cable 1 1/16 miles in length was hove on board.

It is very desirable that the grapnel should be lowered two or three miles from the cable, on the side from whence the current may be running at the time; the direction of a light wind is of less consequence. It is frequently very difficult to choose the proper side, or to ascertain the direction of the main current, till the grapnel is down, when, if anticipations are found to be wrong, there is but little hope of doing any good by means of steam or sail. The alternative of heaving it up, getting into position, and lowering the grapnel again, would nearly occupy the day. Though the operation was completed last summer by September 2nd, the days were never so long as we desired. The

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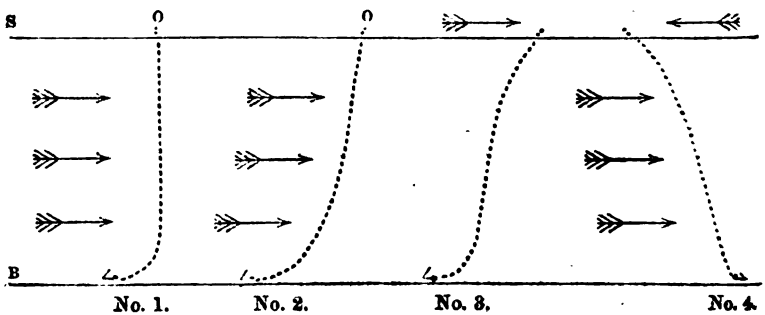
time of lowering the grapnel in 2,000 fathoms occupied about 1½ hour, and 2,200 fathoms, or 2,250 fathoms of rope and chain, were found sufficient at that depth. The rate of drift should be less than a mile an hour.

The following diagram is intended to show the manner in which the grapnel-rope is supposed to be affected by the current, when drifting with it, or being forced against it by wind, steam, or surface current. The arrows below the surface line indicate the direction of the current, and those above show the direction of the propelling power.



The line S represents the surface, B the bottom, two miles deep. No. 1 represents an uniform current the whole depth, and the vessel lying motionless on the surface. No. 2 also supposes the ship to be still, but the current stronger towards the surface. No. 3 supposes the water to be motionless, and the ship moving slowly. No. 4 represents the ship drawing the rope against the direction of the current, and the grapnel just slightly touching the ground.

During the summers of 1865 and 1866, when near the position of the principal operations—52½° N. and 39° W.—the current ran more frequently to the N.E.—true—than any other direction, occasionally as much as three-quarters of a mile an hour; but during the few days the ships were about the second position—52° N. and 36° W.—the current continued to run to the southward.

Whenever it again becomes necessary to repeat the operation of recovering a cable, which had been laid with the usual amount of slack, from 2,000 fathoms, the plan adopted by Sir Samuel Canning in August, 1866, will admit of very little improvement. That is, by raising it half way at two or three points, before trying to lift one to the surface; unless it be almost as desirable to break it, and so make an end, as to get it in at once.

The durability of gutta-percha is believed to be so great, and the motion at the bottom of the ocean so slight, that there appears but little probability of the present generation of civil engineers being required to raise the Atlantic cables of 1865 or 1866 for repair. That these records of industry and science may last a hundred years, is not only my hope and desire, but my full expectation.

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Captain LEOPOLD HEATH, R.N., C.B.: I wish to point out what appears to me a defect in the system adopted for laying this cable, a defect tending to form kinks. Every sailor knows that when you coil down a forebrace, if you lay hold of the end of it and walk away, you will see in the rope as many extra turns or twists as there are circles in the rope coiled down. That is precisely what is done in coiling down the Atlantic, or any other deep-sea cable. The cable is coiled, or rather "flemished" down into the hold; coil upon coil are superimposed, always in the same direction, until you reach the top of the compartment, and then you shift to another. The consequence is, that when you make fast one end of that coil at Valencia, and steam away, you pay out from the ship as many extra twists or turns as there are circles in the hold of that ship. I am not sure that I caught the figures accurately, but I think it was said there were 216 sheaves, and in each sheave there were 316 circles, making in one single compartment 68,256 circles; so that, during the paying out of that one compartment, there were 68,000 extra twists (beyond the normal twist of the cable) paid out with it. Those 68,000 twists are 68,000 elements for the formation of kinks. I do not mean to say that they did form, we hope they will not form, the 68,000 kinks, or even one kink; but still I maintain that there are there, the elements to form kinks, and if other circumstances combine, such as a sudden check to paying out the cable, it is quite possible that kinks might thus be formed. There are but two ways that I know of, of avoiding this. One is, to coil on to a drum, and to pay out from a drum, as was done with the Varna cable. But that, I take it, is impracticable where more than one drum is necessary, because I do not know how you are to connect from one drum to another. It has been proposed by Captain Selwyn that it should be paid out from a single drum in the water; but that would be a great experiment, and I am not surprised it has not been tried. Still I believe the principle is correct, because it will avoid that one difficulty of forming kinks. The second plan would be to fake the cable. That I take it is also impracticable. It would take up too much room. The motion of paying out would be like that of an oscillating steam-engine, as compared with a rotary steam-engine. It would go backwards and forwards, and the bights at the end of the fake would be getting under one another. It would be utterly impracticable. The third plan is my own. It is that the sheaves should be coiled alternately right and left handed; I see no practical objection to that. The only thing would be that your men in the holds, if they did not know it, would be a little puzzled; but as they would be the very men who coiled the cable, I take it it would be a mere matter of drill, so that on each successive sheave being laid out, they should be prepared to reverse the motion. I have brought some pieces of tape, which will show the thing better than anything else. They are just the same as they came out of the shop, except that I have sewn two together. If any gentleman will represent Valentia, I will represent the "Great Eastern." This tape represents one sheave of the cable as stowed in the "Great Eastern." The upper end, of course, would be the end landed. If, Sir, you will be kind enough to represent Valentia, and hold that end of the tape, I will be the great ship, and will steam away and pay out. You will observe, although this is coiled quite flat, that for every turn that is taken out of the hold, there is a turn put into the cable. You see the turns plainly in that tape. You would not have seen it so plainly if I had brought you a piece of rope, and that is the reason I have brought you a piece of tape. Now this represents the way that I should recommend. (Producing another piece of tape differently folded.) This represents two sheaves, the first being coiled in one direction, and the other in the opposite direction. I land the upper end as before at Valentia, and I steam away, taking in as before the materials for one kink in every circle that goes out, until I come to the end of the first sheave. Unless I have made a mistake, and put my tape the wrong way, the next will take in an equal number of twists; but in the reverse way, therefore, on the whole, you will, as you see, have your cable laid out without kinks.

Captain SELWYN, R.N.: Before commencing my remarks upon the main subject, it would be extremely disrespectful if I did not say, what I feel most strongly, that however we may differ on the mode to be adopted in the true solution, or more ready solution of what has been one of the greatest problems of the age, yet there is one point upon which nobody can possibly have a diverse opinion, that is, the merit of

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the undertaking, and the congratulation to be awarded to those who, in the face of danger, difficulty, and discouragement, of every kind, have persevered until they have brought about that magnificent union of the two hemispheres, which we are met here to-night to talk about. Whilst those who have had to do it, have passed through the difficulties, I hope they have learned a great deal from those very difficulties. I hope some of them will become better seamen than they were when they started, and that is only a brotherly wish; and I hope they will not be so subject to those evils which the sea brings upon those who embark upon it for the first time. But I think I do here record in this Institution the opinion of seamen when I say that no seamen could possibly have shown greater perseverance under difficulties, however much their previous knowledge might have enabled them to meet them better. Having thus awarded the meed of praise which everybody must feel is due, as far as I could do it, I must venture to dissent from some of the propositions that we have heard. I am sure that all scientific men will feel that the one of the greatest discoveries a scientific man can make, and the acknowledgment that does him the most honour, is, that he may have been mistaken. With regard to the question whether this generation would have seen the fulfilment of this great operation had it not been carried out by those who have been so fortunate as to do so, I think that is rather begging the whole question. Although we believe that they have shown the very greatest perseverance that was necessary for their object, yet we can scarcely believe that there are not others who might have had equal perseverance, and who might possibly have brought to the subject some more professional skill. Now the very first case in which that comes home to us is this, that whereas the conductor and the insulator of existing cables have been calculated carefully to give a certain speed per hour or per minute, which was supposed to be commercially valuable, and whereas they were calculated as low as possible, in order not to ask for more capital than the public were disposed to supply, the very first discovery made when the cable was laid, showed that we were yet learners in that respect, that a great deal more could be done with that conductivity and that insulation than anybody had supposed before to be possible, by what was really a simple, though very clever discovery of the charging of the cable: that is to say that the conditions under which the messages could be sent were found to be most favourable when they were utterly diverse from those which had previously been predicated. We must never cease to remember also in this question, and we are yet only on the threshold, that ropes are strong only comparatively, and that that rope which you see before you, a shore end, with an outer covering of wire, which looks as though it would resist every strain that could possibly be brought upon it, is in fact, of about one of the very weakest constructions, when called upon to support a great length of its own weight. The cause of the success of modern cables is not the reduced weight alone, but it is that the component parts have been reduced in specific gravity. By a large admixture of hemp, the specific gravity of the rope is less in proportion to the weight than would have been the case had we employed throughout, perhaps a stronger material, but one of greater specific gravity; that is to say, that whereas steel wire will bear about four miles of its own weight in air, fishing gut—which is infinitely weaker—fishing gut in tensile strength, is very much stronger relatively to weight, and will bear some twenty miles of itself hanging in air. Thus we see that the question of strength is solved by the deduction of the weight of the material employed from its tensile strength, the remainder being the whole of the tensile strength really available for your purposes. Now when we consider that a steel wire is also applied, as formerly, round the conductor and its insulator, the gutta-percha and copper wire, and that it has embedded itself in hemp, we see that by no possibility, if a great strain is to be borne by it, can the copper conductor be protected from all strain. The copper conductor will bear its share of the strain, and it will bear it first because of the difference of stretch due to spirals or due to straight lines. It is not that that will very materially affect the whole result, provided there be no very weak point in any part of the copper wire, but it will induce a certain amount of stretching, if there be that strain to be borne. It is not protected, physically speaking, from strain by the outer coating. A cable like that of Mr. Allan, which was once said to be like a man with his bones outside his flesh, or his brains outside his

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dull, a notion with which I do not at all coincide, is really the strongest you can employ, surrounded as it is by a large proportion of material of lighter specific gravity. I think these ideas may have some value in regard to our future progress, and that we shall learn to distrust the deep-sea less, and to distrust the shallow water more than we do now. Reference has been made to danger by Captain Moriarty, who I must say has treated his subject from a point of view which I for one am most delighted to see adopted, that of a thorough seaman and scientific observer, and a man evidently thoroughly capable of dealing with it, so far as his knowledge went. He says that the magnetic influences of the ship are always to be feared. That is perfectly and absolutely true; not less in this instance than in that of our commerce generally. But as I have previously pointed out in this Institution, whenever we will take the simple plan of putting a compass so far above the ship as to be out of the field of magnetic influences, and consult that on occasions as a comparison, we shall cease to fear the bugbear of deviation altogether. Such a place is to be found in the ship at the head of the topgallant-mast, if not lower, and the compass may be there only for comparison, and it will always give true results. It does not matter one iota to me whether my watch keeps Greenwich time or not, so long as I have a chronometer with which to compare it. The magnets, and I speak here with a full knowledge that the question is a very wide one, and one which is probably the most fertile cause of loss and disaster, since the employment of iron ships, except, perhaps that question which was discussed here—the port and starboard helm; the magnets lead in many cases to error: not so much in such a case as the Atlantic telegraph cable, where you pass at once from one shore to another, on the same parallel, but very often where you change your latitude. In taking out cables to India, or to those parts of the globe where we shall be called upon to lay them, it would not be wise in a navigator to trust to his magnets for the correction of his compass without very close astronomical observations to confirm them. The question of the angle in laying the cable is one I have very often spoken of, and it is one in which I am happy to say Captain Moriarty has to a certain extent corroborated the views I have advocated. He has shown the angles at which a grapnel-rope will probably descend, when affected by currents; but the converse of the proposition is also true, that if a ship is passing over the ocean laying the cable, precisely the same operation takes place, as though the current of the water were against the cable; that is to say, curves are induced by the deposition of the cable on the water, probably with no strain other than that due to its own weight, and with a certain proportion of slack which can never be taken up in any other way than by curves. You will never get short curves. You will get long curves, due to the presence either of currents, or to the difference between the forward motion of the ship and the rate of sinking of the cable sideways, or by cutting descent. Therefore the curve will be an upward one in all but a very few cases. The mode of laying cables proposed by me has been alluded to as the best theoretical system, and with regard to that I am quite content to leave it to the decision of future generations. I believe it is the right plan, and I believe it will be adopted when people think it is not too great a novelty. But I must also speak a few moments upon the proposition of my friend Captain Heath. He has spoken of a means of stowing cables which he thinks will obviate the tendency which we all admit, without exception, exists, to form kinks, sometimes causing no very great damage, but occasionally showing themselves to an electrician's great regret, and forming one of his cabinet curiosities afterwards. I have seen them in many telegraph offices. Captain Heath proposes to stow the cable, in alternate layers, from right to left, and from left to right; but I must observe to you that when you deal with a cable of such a weight as telegraph cables are, and of such fragility as light ones are, and you have to deal with that cable going out, at a speed varying from three and four to six miles per hour, which is very rapid indeed; the chances of damage are very great. If a man sees a cable flying out at that rate, he is apt to think it is an excessively dangerous thing to interrupt its motion, and if he, at the end of a certain coil, suddenly changes its motion to an opposite direction, he will find that the forces brought into play are quite sufficient to ruin his cable. Recollect, you cannot govern the motion of a ship suddenly. The ship's speed cannot be slacked

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to meet a sudden motion at all times. She may be going six knots, and suddenly there comes a motion of the cable in the opposite direction. Engineers know how dangerous a thing that is with heavy bodies, even with heavy bodies in slow motion. Now, bodies having high velocity may be light; but the force brought into play may be exactly the same as those of a heavy body in slow motion. There was a point also adverted to, viz., the connection from one drum to the other. I think electricians will thoroughly understand me when I say there is no difficulty whatever in that, that a coil on any possible drum, of any possible size, may be brought into electric connection with any other possible coil on a drum, by means of a friction apparatus. There is no difficulty at all about it; it is too familiar to dilate upon. Having said this much, I think we ought to ask some of the persons who have been joined in Captain Moriarty's exploit, to give us answers to questions which may arise during the discussion if they feel able to do so in Captain Moriarty's absence, as it is very desirable that no question should pass without the answer to it being given.

The CHAIRMAN: If no engineer connected with the great work is present, perhaps Captain Commerell, who commanded H.M.S. "Terrible," will address us.

Captain COMMERELL, R.N., V.C.: I am afraid I can give you very little information upon the subject. Commanding as I did a ship some distance off, I can, as you may be aware, say very little concerning it. But this I can say, that I think Captain Heath is very much mistaken about kinks. I am not aware that anybody observed any kinks over the stern. As I was in the "Terrible," astern of the "Great Eastern" on many occasions, the cable appeared to me to come out as straight as a line; I believe the cause of that was, that as the cable was coiled into the ship a kink was taken in, and as it went out, a kink was taken out. The old cable, when it was raised from the bottom, came up also as straight as a line; and I want to know, if it did not go out as straight as a line, what became of the kinks? Captain Moriarty only said he believed there were kinks, and that at the bottom. We can only speak of things as we see them, and I, certainly, when under the stern of the "Great Eastern" from day to day, and from hour to hour, never saw the slightest appearance of a kink go out. The cable appeared to go out like a silver line, and when the old cable was got up, there was certainly no appearance of kink at all. The only time I ever saw a kink in any one of the cables, was in the Saint Lawrence cable, which was formed entirely of another material altogether. It was coated entirely with steel wire outside. There is no doubt that as the St. Lawrence old cable was got up, there were a good many kinks found in it. The reason of that I cannot inform you. The engineers who laid the cable may be able to do so. I know they complained at the time that it was manufactured at another place. It was very interesting certainly, lying as I did off the buoys, in the "Terrible," to observe the Gulf Stream. You could tell to a hair, when there was comparatively little wind, how the Gulf Stream set. If we missed a buoy, we knew that by steering a certain course, after a certain time, we should pick it up again. At the same time whichever way the wind was, it had the greatest possible influence upon the Gulf Stream. There are some gentlemen here, among others Captain Prowse, who being on board the "Medway," had the opportunity of seeing more than I did of the scientific part of picking up the cable.

Mr. GRIFFITH: The only thing that I would say, is with reference to what Captain Heath said about the kinks. There is not the slightest difficulty with regard to them as far as I have been able to observe. The cable takes precisely the same number of turns in it when put on board, as it does the reverse way when it is paid out. His experiment with the tape is very easily explained. In winding up that tape he took care not to put turns in, and when he came to unwind it he then made the turns. But we take care to put the turns in when the cable is coiled, and consequently, they are taken out when the cable is uncoiled. But kinks do occur, only when a whole turn rises from the coil. You can easily imagine that. Instead of the cable running freely out, if a whole turn rises at once, then a kink may occur. But we never had such a thing occur to us during the whole of the expedition, either last year or this. I never saw such a thing, therefore I do not think, as we have had no difficulty in paying out the cable, that we should raise an imaginary difficulty in order to counteract it. Another remark, with regard to the

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spiral way in which the wire went round the core. Captain Selwin said it would throw strain on the core.

Captain SELWYN: You misunderstand me. I did not say it would throw strain upon the core, but simply that it would not relieve the core from strain.

Mr. GRIFFITH: The core would take a certain amount of strain no doubt, but it is highly elastic. If you will, however, try to break a piece of that core you will find that the gutta-percha parts before the copper wire, and, therefore, I do not see any danger of fracture of the copper. With regard to the old cable, when it was raised, we never found any part of the core damaged, although the outer serving was very much so. I think the fact of not finding any damage done is a sufficient answer to any imaginary difficulty on that point.

The CHAIRMAN: Should there be any other gentleman present who was on board the "Great Eastern," or the other ships, I am sure the meeting would be glad to hear something from an eye-witness.

Mr. CYRUS FIELD: I had the pleasure of being in the expeditions of 1857-58 and 1865-66, and we were never troubled with any of the kinks which my friend Captain Heath fears. I have witnessed over 6,000 miles of wire being laid across the Atlantic, and we had no trouble of that kind. With regard to other parts of the paper which has been prepared by my particular friend, Captain Moriarty, and whom I came here hoping to meet this evening, I am very sorry to hear him use one expression. He says it takes a considerable time for a cable to get to the bottom. That is very indefinite. Sometimes five minutes may seem a very long time. Some people consider several days a considerable time. However his is a valuable paper, and I wish he had made it a little more correct in that respect. He has made one or two errors in regard to the exclusive right which he says I have obtained, and which I will take the opportunity of communicating to him. But I doubt very much what he says, that if the cable had not been laid this year, it would not have been laid at all. I do not believe that. I do not believe that the English and American people would have allowed this enterprise, after having, in 1865, carried it more than two-thirds across the Atlantic, if we had failed this year, to have remained a dead letter. I fully agree with him that these cables will last. I believe they will last after all who are in this room, are in their graves. I know nothing that should injure them, unless it is where they are very near shore, but where they can be easily repaired. I trust they will long remain to be a blessing to both countries.

Captain HAMILTON: I wish to make one remark with reference to these kinks. I was on board the "Great Eastern." I saw many hundred miles put into the "Great Eastern," a turn put into every coil, and the cable came out of the tank in the same way, and it was paid over the stern of the ship. There never was the slightest sign of kink from beginning to end.

Captain HEATH: My statement has caused so much excitement that I think the cap must fit. It is natural that these gentlemen who have succeeded so splendidly should plead that success in proof of the correctness of all they have done, but I am quite sure, as a practical sailor, that it is utterly impossible to coil or to "flemish" down a rope without putting these turns into it. If you take a rope with both ends fast, and attempt to "flemish" it down, you will find in your hand at last a great lump of kinks. What you did in coiling in your cable, was to get your manufacturer to put one end into a lighter. You coiled this cable carefully and snugly into that lighter, and the end on shore turned round once for every circle that you put into the lighter, otherwise you never could have made that cable lie flat. Any sailor will tell you that you cannot coil down a rope with both ends fast; and if you take the fore-brace as I began by saying, with one end fast, unless the other end is left free to revolve, the best captain of the after-guard in the Royal Navy would never "flemish" down that rope. So I think you never could have "flemished" down your cable and made all snug, without having put in one twist to each coil; indeed, you have told us yourself that you put one twist in for every turn. Then as there were 68,000 turns in one compartment, there were by your own admission 68,000 extra twists. That is your statement, is it not? (Yes.) You have put in, by your own admission, 68,000 extra twists into that rope. You then take one end and tie it hard and fast at Valentia, and the other end is hard and fast in the hold

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of the ship. Now then, carry your ship off two or three thousand miles, paying out as you go—how can those twists come out? since both ends of the rope are fast. Every twist you put in remains there. I did not say you necessarily made kinks, but it seems that Captain Moriarty thinks that kinks are there.

The Rev. A. Drew: I happen to remember reading when the first Atlantic cable was laid, that this point was anticipated. It was looked upon as rather a ropemaker's question than a sailor's. It was anticipated that kinks would exist. My belief is that Captain Heath is right, that the kinks are there, but what became of them? The ropemaker will tell you that he made the rope originally slack enough to take up all the kinks, and I believe that is the solution of the difficulty.

Mr. Cyrus Field: One word in regard to what the gentleman has said in reference to those kinks.

The Chairman: I thought you said you saw none.

Mr. Cyrus Field: We have perfect evidence of that with regard to a cable eleven miles long, which we laid from Newfoundland. We often had to cross the strait of Northumberland eleven miles to repair the cables, and we underrun it every length without finding a kink. We have laid it down, and have taken it up.

The Chairman: I think we have exhausted the subject of kinks. It only remains for me to ask the meeting to convey through our Secretary, our thanks to Captain Moriarty for his paper. After the elaborate figures we have heard read to-night, which were not always very easy to follow, we must all I think feel how carefully this enterprise has been prepared, how every calculation has been gone into, and how every experiment has been made that could insure its success. You even see that the very buoys answer their purpose to a nicety. These minute details prove how very great has been the care bestowed upon the operation of laying the cable. I am sure that we are all delighted that its success has been so perfect in spite of kinks.

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Evening Meeting.

Monday, March 18th, 1867.

MAJOR-GENERAL J. T. BOILEAU, R.E., F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between the 4th and 18th March, 1867.

LIFE.

Murray, John George, Lieutenant R.A. 9*l*.

ANNUAL.

Ellis, C. D. C., Maj. 60th Roy. Rifles. 1*l*.
Edmonds, Charles, Rear-Admiral. 1*l*.
Hill, the Rev. Pascoe Grenfell, Chaplain, R.N.
Crawford, H. P. R. F., Lieut. H.M. Madras Staff Corps. 1*l*.
Farquharson, M. H., Lieut. R.M.L.I. 1*l*.
Crickmer, Charles James, Lieut. Durham Art. Mil. 1*l*.
Osborne, Eric Willoughby, Ensign 91st Highlanders. 1*l*.
Hotham, Charles F., Captain R.N. 1*l*.

ON THE CONVERSION AND RIFLING OF CAST-IRON ORDNANCE, AND ON CHILLED WHITE IRON PROJECTILES.

By Major WILLIAM PALLISER, Unattached, late 18th Hussars.

I propose to divide my remarks this evening into three headings: I. The rifling of heavy cannon lined with soft wrought-iron coiled barrels. II. The converting and utilizing of our existing cast-iron ordnance. III. Chilled white iron projectiles. The third heading, properly, is not included in the subject announced for this evening, but since it treats of a materiel which has been largely introduced into the Service, I trust a short notice may not be unacceptable to you.

I shall begin by asking you to be good enough to follow me through what in another place have been lately termed some "Autobiographical reminiscences" as I am anxious to show how working at certain subjects, enabled me to observe wants and defects, and how the experience of these wants and defects induced me to turn my attention to supply and remedy them.

I. *Rifling of Heavy Cannon.*

Some time during the year 1853, I happened to hear it stated that the impossibility of rifling heavy cannon was an universally admitted fact. I had previously made many experiments with cross-bows from which I had shot arrows, bolts, bullets, and even small shot, and had thereby acquired a smattering of the flight of projectiles. In consequence of this knowledge, I believed that an elongated shot could be made to fly point foremost from a smooth-bore gun, by causing its

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centre of gravity to be placed in front of the centre of the resistance of the atmosphere. This idea has since, and I believe had previously suggested itself to many others. I began by firing a variety of these shells from an ordinary smooth-bore fowling piece, and after a time attained considerable success. These small shells had percussion caps on their points, and invariably exploded against a wooden target at 100 yards distance. I next fired some similar shells out of a cast-iron gun—either a 4-pounder or a 6-pounder—at Dalkey Island from the main land, a distance of about 800 yards. Most of these shells exploded on striking. As, however, they weighed about three times as much as the round shot which the gun was intended to fire, it was believed that their weight might burst the gun, and hence it was always fired with a slow burning fuze, which gave us time to run away and get under cover. I submitted these shells to the Ordnance Select Committee, and they were tried by them during the month of August, 1854, at Shoeburyness, which place was at that time in its infancy. The results were unfavourable, owing to the great amount of windage which I was desired to allow, and which at that time was thought to be necessary. The shells remained point foremost during their flight, but they wabbled very much, and their range was very bad. I have since satisfied myself by further experiments, that great range and accuracy can be obtained with accurately fitting shells with heavy heads, but since there are insuperable objections to mechanically fitting projectiles, and since all difficulties connected with the rifling of cannon, which confers such extraordinary range and accuracy have since been overcome, there would appear to be no object for continuing experiments of this kind, excepting as an interesting scientific enquiry. Fig. 1, Plate VI, illustrates the shells which were fired at Shoeburyness in 1854. Some had helical flanges upon their surface, in order that the pressure of the air upon them might cause the shells to rotate. These flanges, however, confer no advantages. Like all inventors, I was at that time much impressed with the value of my invention, but I perceived that if it were necessary to run under cover every time they were fired, these wonderful projectiles could not be introduced into the service, and hence it was that my attention was turned, at that early period, towards the construction of strong cannon. I had previously watched the manufacture of twist, or, as they have since been called, "coiled" wrought-iron barrels at the forges of Messrs. Truelock and Harris, gunmakers, of Dublin, and had learned from them the great strength derived from this process of manufacture, and I commenced my experiments by casting several small cannon round wrought-iron twist barrels, in the same manner as I still propose to construct heavy guns. By this time, I began to doubt the truth of the statement, that heavy cannon could not be rifled. The letters given below show the precise dates of the experiments:—*

* No. 1.

Gun Manufactory, 233, High Holborn, W.C., Feb. 24, 1866.

SIR,—I beg to hand you the statement of the pieces of barrel I have rifled for you for insertion into cannon, and of the blasting fuze and cartridges, &c., I made

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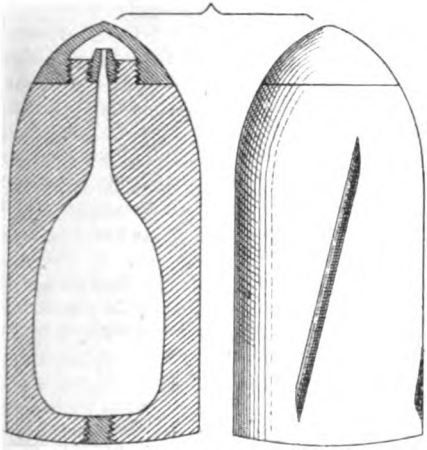
Fig. 1.

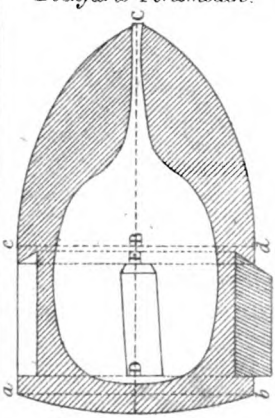


Scale ½.

Palliser's percussion Shell with Gun Metal false head fired by Ordnance Select Committee August 1854 from Smooth bore 9 Pdr.

Fig. 2.

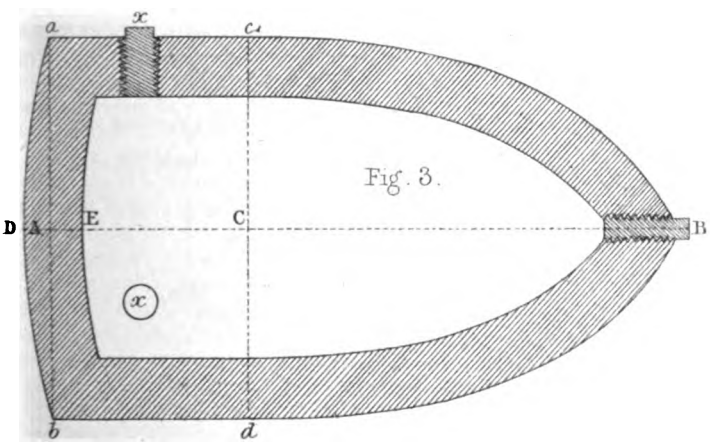
Original Sketch received from Lieut.ᵗ Palliser in Septr. 1855 by Andrew Murray Esq. H.M. Dockyard Portsmouth.



A . D.	one inch
D . E.	six inches
A . B.	eight inches
B . C.	twelve inches
a . b.	13ᵉ inches
c . d.	13 inches

Fac Simile of original Sketch dated Malta Octr 23rd 1855.

Fig. 3.



A . B.	20	D . E.	2
A . C.	6	a . b.	12
A . D.	1	c . d.	12

x.x. Round Copper Plugs screwed through the Shell, diameter 1 inch total length 2.6 outside the shell 5 inch

J Jobbins

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Shortly afterwards, the bursting of several 13-inch mortars at the bombardment of Sweaburg turned the attention of many towards constructing stronger guns; and many patents were, in consequence, taken out with that object. I found my small guns so strong that I could not burst them, and now I turned my attention to rifling. Not having sufficient mechanical appliances for rifling guns, I cast several small mortars over sand cores which had the rifling in relief upon their surface, and thus formed the grooves in the mortar. I tried in this manner two or three degrees of rapidity of spiral, and finally made a 6-inch mortar rifled with three grooves. Unfortunately it burst in proof. I,

for you at the time. I am prepared to state that I understood from you that you wanted me to procure and rifle you pieces of gun barrels, for the purpose of inserting in cannon, and that I rifled you three or four pieces in 1854.

I have the honour to be, Sir, your obedient servant,

JOHN W. P. FIELD.

No. 2.

Major Palliser bought of Parker, Field, and Sons.

1854.
July 26. Rifled a barrel twice.
Aug. 1. Powder magazine.
Coil of fuze.
2. Rifled a musket barrel.
1 lb. powder.
11. 1 lb. powder.
17. 1 lb. powder.
Sept. 22. 1 coil blasting fuze.
Rifled a barrel.
Oct. 5. 3 lbs. powder, T.P.
7. 1 do. do.
3 yards blasting fuze.
20. 2 lbs. powder.
5 yards fuze.

The above is a correct extract from our books.

JOHN W. P. FIELD.
Feb. 26, 1866. for Parker, Field, and Sons.

No. 3.

W. Palliser, Esq., to S. H. Seager.

108, St. Martin's-lane, W.C., Oct. 20, 1854.

1854.				
Oct. 20.	To making in oak a large-size model ship's gun-carriage complete.....	£2	1	9
31.	To making in oak a large-size model of field-piece carriage.....	5	6	3
		£7	8	0

The above is a correct extract from our books.

July 14, 1866. T. T., for S. H. SEAGER.

No. 4.

15, Gate-street, Lincoln's Inn-fields.

SIR,—On referring to our books, we find that we finished turning a model cannon

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however, made another, which was fired by Capt. Sir Thomas Maitland, now the Earl of Lauderdale, on board Her Majesty's ship "Excellent," during the month of August, 1855. The shells employed, had iron flanges cast on them to take into the grooves; these flanges were faced with strips of copper, attached by means of screws. The copper strips were, however, blown off, and could be seen falling into the water. The shooting, however, was indifferent, owing to there having been too much windage. By the kind permission of Admiral Sir Thomas Cochrane, Port Admiral, and Admiral Martin, Superintendent of the Dockyard, the mortar was bored up to a 7-inch, and again rifled with three grooves.

The mortar having been re-rifled with a slotting machine, the grooves were of unequal depth and did not follow the curved surface of the bore. The long flanges on the shells would in consequence not load, and I was obliged to shorten them, until they became mere studs of iron. The windage was reduced to about ·05 of an inch, and, so far as could be judged, by firing down a range, covered with water, the practice was very good. One thing was noticed, namely, the tendency of the shells to deflect to the right. The fact of the iron studs on the shells cutting the rifle grooves was observed, and further that the

for you on the 10th November, 1854. The cannon was of cast iron, cast over an internal tube of wrought iron.

We are, Sir, yours faithfully,
CLARK AND Co., Engineers.

Captain Palliser to Clark and Co.

1854.
Nov. 10. To turning and finishing a cannon, painting, &c. £2 2 0

No. 5.

I, Charles Moritz, engineer, do hereby certify that I finished turning this gun for Captain Palliser on or before the 10th of November, 1854, and I can also identify the gun, both by the pattern and by having filled up with lead some blow-holes caused by faulty casting. The gun is made of cast iron, cast over an internal tube of wrought iron.

Signed, 17th day of September, 1863. CHARLES MORITZ.
39, Lamb's Conduit-street, W.C.

Witness, Edmund Taylor, 7, Russell-terrace, N.W.

No. 6.

British Museum, May 26, 1866.

MY DEAR PALLISER,—I have much pleasure in stating that, during the year 1854, you were living with me in my chambers at 13, Gate-street, Lincoln's Inn-fields, and that, during the summer and autumn of that year you were occupied in making small guns, by casting the barrels over a central tube of wrought iron. On one occasion in the beginning of October, I went with you to Erith and witnessed some of your experiments with them. Towards the end of November, 1854, you left me, and went to Dublin.

I am sincerely yours,
WM. S. W. VAUX,
Keeper of the Coins and Medals, British Museum.

Major Palliser, &c.

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greatest injury was done at the bottom of the grooves where the shells first began to move.

My first plan to obviate this was to countersink copper strips in the shot, as shown in Fig. 2. I am indebted to Mr. Andrew Murray, Chief Engineer of Portsmouth Dockyard, for the originals of these drawings. I went down to Portsmouth a couple of years ago, and asked him whether he had any record of my experiments, when he produced from a drawer my letters and drawings, which he had carefully docketed and dated; he also took me to a heap of old iron rubbish, from under which he produced the 7-inch rifled mortar itself. This mortar is at present on the gun wharf at Woolwich, in charge of Captain Gordon, C.B., Principal Superintendent of Stores. It is probably the first heavy piece of ordnance ever rifled on the French system.

If any one will take the trouble to look at the grooves of the mortar, he will see how they have been cut by the iron studs of the shells. I should mention that the shells weighed between 60 and 70 lbs., that the mortar was fired with 4 lbs. of powder, and that a few rounds were fired with only 1 lb. in order to watch the flight of the shell. I well remember that their flight was perfectly steady, that the shells appeared like humming-tops as they passed through the air, and further, that their axes always remained tangents to their trajectories, *i.e.*, that the shells descended with their points foremost. I have often since been surprised to see it stated in scientific works that the axis of an elongated rifled shot remains during its entire flight parallel with the axis of the gun from which it was fired.

I sailed for Malta in H.M.S. "Urgent," the day after the last experiment which took place, on Saturday, Sept. 29, 1855.* We had only left Portsmouth some twelve hours when we burst our steam-pipe, and had to put back into Plymouth for repairs. I wrote from that place the following letter to Mr. Murray, which contains my first proposal for an increasing spiral. My letter is only dated Devonport, Monday. But I am able to fix its date as Mr. Murray has written upon it, "Answered Thursday 4th Oct., 1855."

"I send you a drawing of the mortar sent. If you notice the groove you will see there are two pairs of parallel lines, one pair are straight, the others are supposed to represent the turn beginning by degrees and at last getting into the direct deflection; if the latter could be easily done I should prefer it, as the shell would then be turned by degrees, and not receive the full wrench at the first shock of the powder."

My next letter, dated Malta, Oct. 23rd, 1855, contained a more advanced drawing (Fig. 3.) of the studding system. It says,—"I enclose you a small plan of the shell for a 12-inch mortar, which I think

* Since reading this paper, I have received the following letter, which confirms the accuracy of my dates. The postmark on the envelope, Sept. 30, 1855, shows that the mortar was fired Sept. 29th. "H.M.S. Urgent, Sunday. My dear Vaux,—The mortar was quite successful yesterday, and I have applied to the Admiralty for leave to have one made like it, only of 13-inch bore, and Sir Thomas Maitland will recommend its being done. We sail in an hour. . . . Mr. Murray, the Chief Engineer, will undertake the manufacture of it. There is a man waiting to take the letter on shore, so I must say, good-bye. Yours sincerely,—William Palliser."

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would be quite large enough, as the conical 12-inch shell would be larger and heavier than the 13-inch now in use."

The following is an extract from a third letter, dated Camp Notre Dame, Malta, Nov. 20, 1855. "I am making a model 2·5 inch diameter of bore, which I shall send home if it answers; the grooves have a terminal turn of ·6 inch in a foot, but the initial turn is so slight as to be barely perceptible; this goes on increasing till it arrives at the maximum turn as above. I am afraid this is badly expressed, but I think you will understand what I mean. You were quite right in supposing those to be plugs of a mixture of copper and brass, to be screwed into the shell to fit in the grooves. I think they will be quite strong enough to stand the violence of the explosion, and also of the friction. I am not quite confident that ·6 inch a-foot will be sufficient turn for the grooves, but I am decidedly of opinion that it will; and it would be a great advantage if it were, for two reasons—first, it diminishes the friction on the grooves, and the less rapidly the shell rotates, the less will be the deflection to the right.* I also think that ·25 of an inch will be sufficient depth for the grooves, as it will weaken the mortar less,† and likewise cause a less deflection to the right. I would on no account have a greater windage than ·05 of an inch, and would like to have it less if they will allow it at Woolwich."

Now a turn of ·6 inch in one foot is the same as a turn of 6 inches in 10 feet. In a 12-inch rifled gun this amounts to about one turn in 63 diameters. You will then observe that I proposed a 12-inch rifle with ·05 inch windage, a spiral of 1 turn in about 63 diameters, and gun-metal studs screwed into the shells to take the rifling. I find from Capt. Noble's Report, in 1865, on Ballistic Experiments, page 9, on the initial velocity of projectiles fired from the 600-pounder muzzle-loading rifled gun, that the windage for cast-iron shot is ·05 inch, for steel shell it is ·06 inch, and that the spiral is 1 turn in 65 calibres. The windage at present adopted in our service is ·05 of an inch over the studs and ·08 over the body of the shot, and I think the latter might with advantage be reduced to ·05.

I am still of opinion, notwithstanding all the experience that has since been obtained in rifling, that I was right as regards windage, spiral, material of studs, and their mode of attachment as then proposed for a heavy rifled mortar, designed to fire shells of about two diameters in length and containing large bursting charges, and I propose shortly to bring forward such a mortar for trial. I am anxious, however, that it should be well understood that I do not intend by this statement to interfere with the independent enquiries of others who may have been led to somewhat similar conclusions, especially those of Sir William Armstrong, to whose gun I have alluded, and who has so liberally assisted me of late in constructing guns and carrying out my experiments. My object in making this detailed statement has been to show that upwards of twelve years ago I had worked hard

* This sentence shows that we had noticed the tendency of the rifled mortar shell to deflect to the right.—W.P.

† The grooves in my first mortar were deep. It burst right along the grooves, and thus showed me that deep grooves were a source of weakness.—W.P.

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at this subject, and to enable you to judge of the progress I had made in it at that time.

On my return to England in 1856, I resumed my experiments by making and rifling several small cannon lined with coiled barrels, and firing copper-studded shot from them; and in January, 1857, I again submitted this system of rifling to the Ordnance Select Committee. Owing to circumstances connected with my profession I had neither time nor opportunity thoroughly to go into the subject until the year 1862, when, owing to a severe kick which I received from a horse, I was placed for several months on the dismounted list, and was thus able to devote my leisure time to making a more extended series of experiments, as well as to compiling a treatise on compound ordnance, which I submitted to the Ordnance Select Committee on or about the 12th November, 1862.

In that treatise I proposed the addition of a small leading stud, in order to combine the advantages of an increasing spiral with those of a double bearing. The theory of the advantages conferred by the accelerated spiral is thus described in page 54:—

"First. If the accelerations of a projectile, from its first starting from a state of rest until it left the muzzle of a gun, were uniform, *i.e.* if equal increments of velocity were added in equal times, then would a straight line inclined at the required angle be the form of groove that would by a uniform pressure gradually accumulate the angular velocity in the shot during its passage out of the gun. For since the increments of velocity in the shot were assumed equal for equal times, the pressure that produced them would always be uniform; and since the pressure on the driving edges of the rifling is always proportional to the pressure that moves the shot, it will be uniform also.

"Secondly. If the velocity with which the shot moved were uniform, *i.e.* if it started off at once with a finite velocity which is not increased during its passage out of the gun, then it will be evident by the former reasoning that the required angular velocity would be uniformly accumulated by a parabolic curve.*

"Thirdly. If, however, as is actually the case, the projectile suddenly starts off with a high initial velocity, and that this velocity is further accelerated during the passage of the shot out of the gun, it will be seen that the rifling that will cause a constant tangential pressure will be shown by a curve lying between the straight line and the parabola."†

"The spiral which I propose, is such, that were the bore of the gun laid out flat, the grooves would become arcs of a circle, whose radius would be determined by the length of the bore of the gun, and the final angular velocity required.

"The arc will, therefore, be constructed in the following manner:

"Given A B (‡Fig. 7, Plate viii), the length of the barrel to be rifled, and α the final angle of the rifling, at B draw B O perpendicular to A B

* Mr. Twisden pointed out to me that the curve would be a parabola.—W.P.

† The direct, or unaccelerated rifling, causes too great a wrench when the shot first starts, and the parabolic curve does the same when the shot approaches the muzzle.—W.P.

‡ Fig. 9, Plate v in treatise.—Ed.

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and make B O of such length that $\frac{A B}{B O} = \tan \alpha$. With O as centre and O B radius describe the arc B D D', then B D will be the required curve since a tangent to the arc at D will make an angle with A B $= \alpha$; should it be desired that for a short distance towards the muzzle the spiral should not increase, the tangent D T will give the straight line."

The object of the "differential studding," as Mr. John Penn has aptly termed them, is described at page 75 of the same treatise.

"I at first experienced some difficulty in combining a shot with a double bearing and an accelerated spiral; for since the angle at which the grooves are inclined is continually increasing, we should have the gun trying to turn the fore part of a rigid shot faster than the hinder part, which would be impossible.

"This object is attained (*Fig. 6, Plate vii) by making the rear stud larger than the front one; thus at starting the three studs in rear do all the work of turning the shot, since E E' is the driving edge of the groove when the shot first commences to move. This work, however, is inconsiderable, as the angle of the turn at first is zero. As, however, the shot travels up the bore, the friction will wear down the rear studs, and the assistance of those in front will thereby be gradually called in.

"For a short distance towards the muzzle the rifling will become straight lines, at which place, since the common tangents to the bearing points on the circumferences of the studs become parallel to the driving edges of the grooves, the work will be equally distributed amongst all the studs, and thus the shot, prior to leaving the gun, will be steadied at six points—three in front and three in rear of its centre of gravity. The rear studs will be made large enough to fill the grooves; the size of the front studs will be determined thus: draw A A' a tangent to the larger stud at C, making an angle A' A H equal to the final angle of the rifling. From O, the centre of the rear stud, draw O O', making angle O' O H equal half the angle A' A H. It will readily be seen that a circle described with any point O', along O O', as centre, and the perpendicular O'P let fall upon B B' as radius, will touch D D', and that the shot will freely enter the gun, and that the bearing edges of the studs will all press equally on the driving edges of the grooves as the shot approaches the muzzle."

In this pamphlet I proposed a gun rifled with 3 grooves and an accelerated spiral of which the terminal pitch should be an angle of 5°, *i.e.*, 1 turn in 37 calibres. I fixed upon this ultimate pitch as it was the one which had been adopted by Sir William Armstrong, for the turn of the uniform rifling of his 7-inch breech-loading gun.

Some time after this, the Ordnance Select Committee rifled a gun with three grooves and an accelerated spiral to fire a projectile which had been adopted in the French service, namely a shell with single studs round the centre of gravity (see Fig. 4, Plate vii). This gun was included in the competitive trial which commenced on the 28th June, 1864. Some one, I don't know who, proposed putting in a second small stud in rear (see Fig. 5, Plate vii). This was but a bad imitation of my previous proposal.

* Fig. 3, Plate v in treatise.—Ed.

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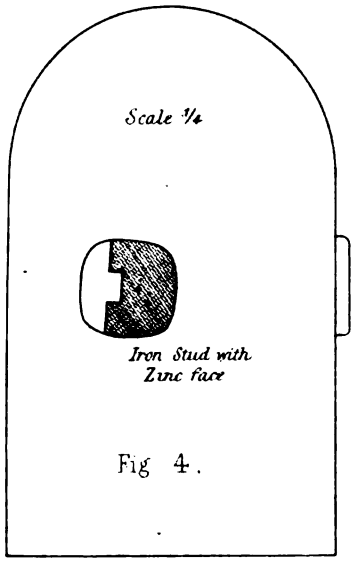

Fig 4.

French Shot or first supply fired from three grooved Woolwich Rifled Gun.

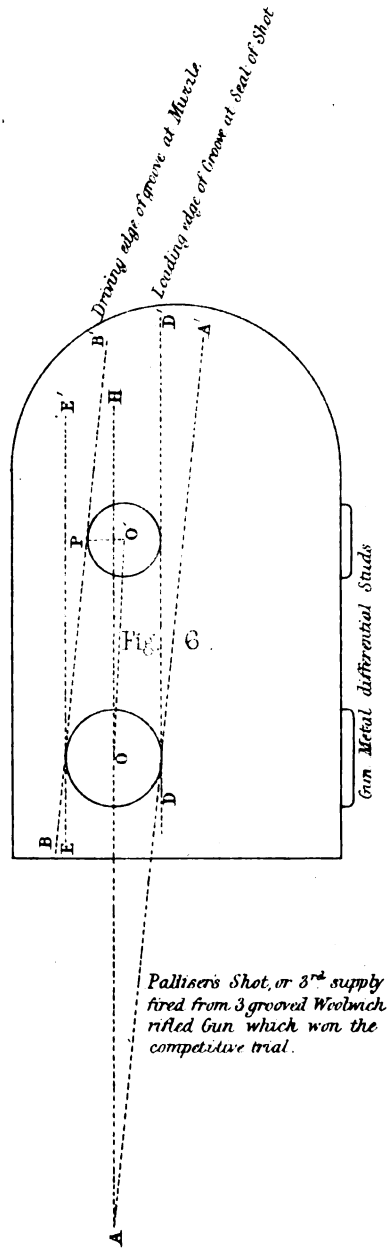

Fig 6.

Pallisers Shot, or 3rd supply fired from 3 grooved Woolwich rifled Gun which won the competitive trial.

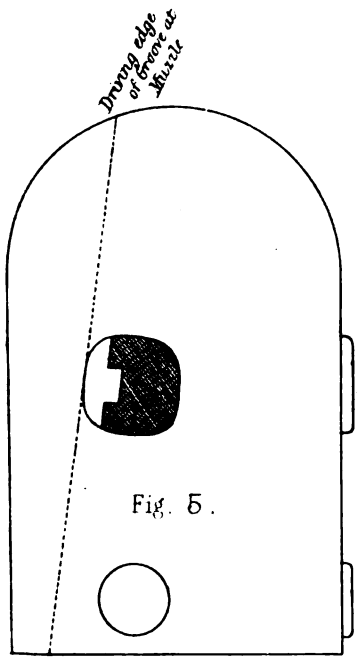

Fig. 5.

Shot of the 2nd supply fired from 3 grooved Woolwich rifled Gun with small Stud attached in the wrong place

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Fig. 10.

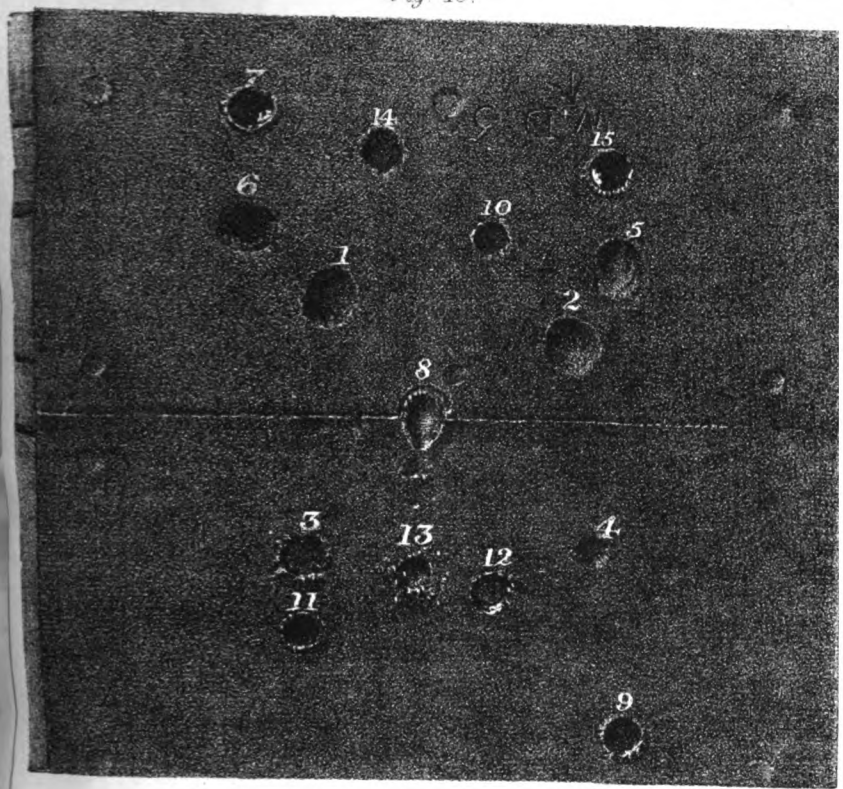


Fig. 8.

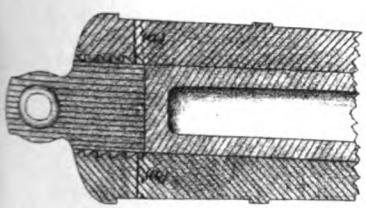


Fig. 9.

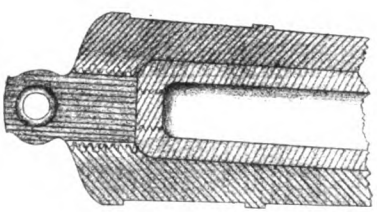
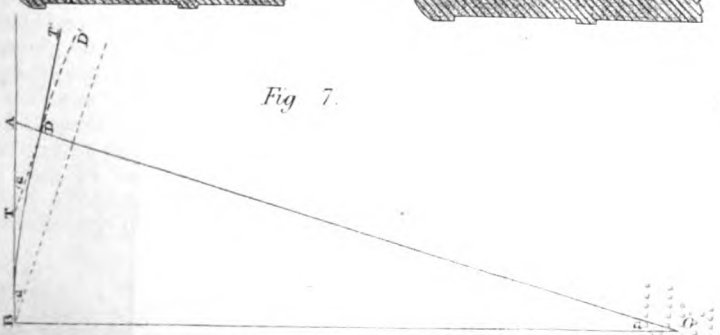


Fig 7.



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The Ordnance Select Committee, however, tried both methods of studding from an Armstrong muzzle-loading gun, which for the sake of distinction was termed the "French" gun. Both methods of studding turned out failures, the zinc studs which no doubt may have answered well in the French cast-iron guns, fired with low charges and weak powder, were blown off or destroyed by the shock of the large charges of our strong English powder, and the gun made the worst practice of the three remaining in the competition.

I was now invited by the Ordnance Select Committee to send in the shot I had proposed in my pamphlet of November, 1862, and which, as I have shown, were shot perfected from my original proposal of 1855. As soon as these shot (Fig. 6, Plate vii) were tried, the gun came out by itself and beat all the others. I shall now denote this gun as No. 1. The relative accuracy of the three guns which remained towards the end of the contest is given as follows, in a Report published for the House of Commons, July 4, 1865.

No. 1.	Mean difference of range	27·2 yards.
	Mean reduced deflection	3·6 ,,
No. 2.	Mean difference of range	38·3 ,,
	Mean reduced deflection	7·4 ,,
No. 3.	Mean difference of range	47·6 ,,
	Mean reduced deflection	6·7 ,,

Their respective parallelograms of error would be, No. 1, 78 square yards; No. 2, 283 square yards; No. 3, 319 square yards. That is to say that the shooting of No. 1 gun, firing shot studded on my plan, was about three or four times as good as the shooting of the other two guns. The practice of No. 1 gun was very good, when it is remembered that the 7-inch shot were short, since they weighed only 100 lbs. and were solid, and that the windage amounted to 8-hundredths of an inch. This system of rifling has since been experimentally worked out and perfected by the Ordnance Select Committee, and to accomplish this end many long and carefully conducted experiments have been made by them. The system, as now perfected by them, has been adopted into the service for the rifling of our heavy muzzle-loading guns, and by direction of Earl de Grey, late Secretary of State for War, has been denominated the "Woolwich" system of rifling.

II.—*Converting and Utilizing Cast-Iron Ordnance.*

I propose to utilize existing cast-iron guns in two ways. First, to bore up and line with a coiled wrought-iron rifled barrel those cast-iron guns whose size and pattern will admit of their conversion into rifled guns suited to the requirements of modern warfare.—Secondly. To melt up and recast the others—round similar wrought-iron barrels—into rifled compound guns of the required dimensions.

Having, as previously stated, made up my mind, during the year 1862, once more to resume my enquiries, I determined to place the subject in such a manner before the authorities as would ensure a trial, viz., to submit my plans in a finished state, to accompany them with the

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results and specimens of previous experiments as well as with a theoretical treatise corroborated by the calculations of eminent mathematicians, and to produce a rifled gun which had been fired in public, and which could be fired again. I accordingly sought and obtained friendly assistance from Andrew Hart, LL.D., Senior Fellow of Trinity College, Dublin; and also from the Rev. John Twisden, M.A., of Trinity College, Cambridge, and Professor of Mathematics at the Staff College. The calculations independently contributed by those gentlemen to my Treatise on Compound Ordnance will be found at the end of this paper, and it will be interesting to observe how exactly they agree with each other in their conclusions and how exactly those conclusions agree with the practical results of the experiments which will be herein detailed.

I commenced by making a gun similar to the 10-inch cast-iron shell gun of the service—to about $\frac{1}{4}$ scale—and lining it with a coiled wrought-iron barrel. This gun I tested to destruction with increasing charges. I regret that the record of its endurance test, which was very severe, has been lost. The barrel which was rifled had been made in two lengths which were screwed together. The object of this arrangement was to stop the rifling at such a point as to leave a smooth-bore chamber. The first intimation of failure was the separation of the barrel at the joint, and subsequently the casing was broken off. I derived much encouragement by finding that the barrel itself did not burst, Fig. 12, Plate ix. Next, in order to demonstrate the necessity for employing a barrel of *coiled* wrought iron, I made the gun, shewn in Fig. 11. The cast-iron portion of that gun was run round a barrel formed out of a solid bar of the best wrought iron, and bored into a tube. This gun burst at the second round with a charge of only 4 oz. of powder and a shot of $2\frac{1}{2}$ lbs. weight.

I may here mention that subsequent to this experiment a large number of wrought-iron guns were lined with solid forged tubes. This was done on account of the difficulties at that time experienced, in making sound coiled barrels. The flaws or bad welds in coiled barrels always run circumferentially and although they are no doubt eyesores they are in reality of but little importance. Further the iron used at that time in the manufacture of coiled tubes was of too hard and steely a nature to weld well. This hard iron was deemed necessary in order to resist the crushing force of the powder. Such, however, is not the case, and it is found that soft ductile iron, which I proposed* for making coiled tubes, welds very perfectly, and further that it is set up and rendered dense by a couple of heavy proof rounds. The effect of these rounds is, slightly to bulge the bore at the seat of the charge, and I, therefore, submit my large guns to a severe "setting out" proof before they are fine-bored. The finishing cut thus removes the bulge, and it has now been proved that no further bulge is caused by firing service charges. It has since been conclusively proved that all solid forged barrels are liable to split, and in consequence, it has

* I should wish the innermost tube to be constructed of the softest and most ductile wrought iron, such as Bradley (L.) Charcoal Iron.—Treatise on Compound Ordnance, Jan., 1863, page 17.—W.P.

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Fig. 11.

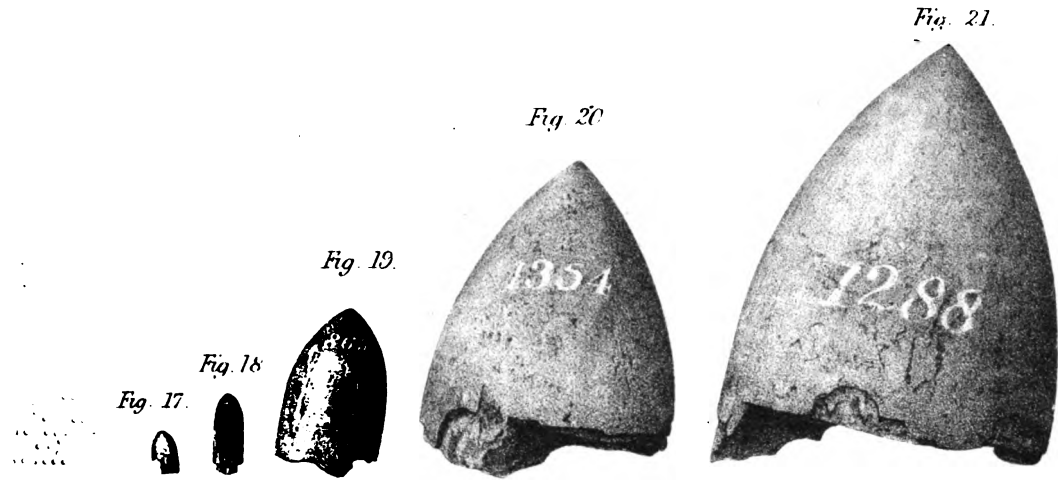

Fig. 21.

Fig. 20

Fig. 19.

Fig. 18

Fig. 17.

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been found necessary to bore them all out and to replace them with coiled tubes.

After making and destroying several other guns, I made a rifled gun 1½ inches in bore, which I fired during the month of October, 1862, down the range at the Pigeon House Fort, Dublin, in the presence of Colonel Blane, A.A.G., and Colonel Phillpotts, commanding the Artillery. I then took my guns and models over to the Ordnance Select Committee, and at the same time submitted my Treatise on Compound Ordnance. The Committee at once decided upon giving my system a trial and placed a 68-pounder cast-iron gun of 95 cwt. at my disposal.

They decided that I should be allowed to convert their gun, which was of 8 inches calibre, into a 9-inch smooth-bore lined gun. Before doing this I made the following inductive experiment, for I had not previously constructed a similarly proportioned gun. I made three models of the 68-pounder 8-inch gun, accurately to the scale of 1-8th; one of these was a plain cast-iron model of the gun itself; the second was made of a forging of the best wrought iron but not coiled; the third was made of cast iron and lined with a coiled barrel 1-8th of an inch thick, it was 1-inch in bore; and thus represented, to scale 1-8th, the 68-pounder gun converted by means of a barrel two inches thick into a 9-inch gun. The programme I laid down for each gun was as follows:—

Charge Round.	oz.		Weight of Cylinder in oz.
1 ..	1	.....	12
1 ..	1	.....	24
1 ..	1	.....	36
1 ..	1	.....	48

Then repeat the programme with a charge of 2 oz.; then with 3 oz.; and lastly with 4 oz. The cast-iron gun burst at the 4th round, viz:—1 oz. of powder and a cylinder of 48 oz. The wrought-iron and the lined gun each completed the test. They were then submitted to the following test, viz.:—They were loaded with 1 oz. of powder and an iron bar which accurately fitted the bore and projected beyond the muzzle of the gun. The breech of the gun was placed against a cylinder of about 1,000 lbs. weight, and a cylinder of 200 lbs. weight was laid against the end of the bar which projected; the wrought-iron gun burst at the first round, but the cast lined iron actually blew the cylinder of 200 lbs. weight right against the opposite side of the cell. The gun was then loaded with 2 oz. of powder and the test repeated, when it burst.

The reason for my giving the details of an experiment made on a scale so small that some consider it to be, in consequence, worthless, is, that I attach the greatest importance to such inductive experiments in which care is taken that all conditions be strictly proportional and all sources of error eliminated, and I think that one reason why experiments made on a small scale, carry so little weight is, because apparently trifling elements are apt to be overlooked and conditions allowed to creep in which vitiate the comparisons. In order to convert the 68-

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pounder into a 9-inch gun, it became necessary to bore it up until a ring of cast iron only one inch thick was left near the muzzle, and some people thought that the "jar" or "vibration," or "concussion," or some such indefinite cause would break the cast iron at that place. But since the metal at the muzzle of the model gun had been only 1-8th of an inch thick, and as nothing of the kind had occurred, I carried out my proposal.

In the early part of the year 1863, the 68-pounder 9-inch gun was completed in the Royal Gun Factories, and it passed through its "test to destruction" without bursting. This test consisted of 100 rounds of 16 lbs. of powder and cylinders increasing every 10 rounds, by the weight of one sixty-eight pound shot. Thus the first ten projectiles weighed each 68lbs.; the second ten 136lbs.; the third ten 204 lbs., and so on, the last ten weighing each 680 lbs. The recoil was very violent, and smashed several carriages. The gun was then suspended in iron slings, these were also broken, and the gun flung itself out of them. It pitched muzzle foremost on the ground which was paved with large stones. The muzzle uprooted some of these and burried itself to a depth of about two feet in the earth, but suffered no injury whatever. When the test was completed, it was found that the lining in the gun had been fissured, or, as it is technically termed "guttered" in front of the seat of the powder; these fissures were upwards of half an inch in depth, and were caused in the following manner. A difference of 15-hundredths of an inch had been allowed between the diameter of the cylinders and that of the bore of the gun. When loaded, the cylinders lay on the lower part of the bore and thus left a lunated space between its upper surface and that of the bore of the gun. When the gun was fired, the heavy cylinders at first moved slowly off, and thus the inflamed gas rushed through this vacant space and eat away the iron of the tube immediately in front of the charge. In this state the gun was then put through a second test with 32 lbs. of powder, and in consequence of the additional 16 lbs. lying under the injured—I may say destroyed portion of the barrel—the gun burst at the 7th round with a shot of 200 lbs. weight and 32 lbs. of powder.

The next gun, to which I shall allude, was a 68-pounder, converted into a 7-inch rifled gun by means of two tubes one within the other; the object being that when the inner tube had been destroyed by continuous firing, there might still be a gun to fall back on, which was lined with a stout coiled wrought-iron barrel. For if the inner barrel 1 inch thick were to split, we should still have a lined 9-inch smooth-bore gun left, and the great strength of such a gun has just been shown.

The following is extracted from the Report of the Ordnance Select Committee upon its trial.

"Between the 8th October, 1864, and the 16th January, 1865, the gun went through 800 rounds, viz., 20 rounds of 12 lbs., 40 rounds of 20 lbs., and 740 rounds of 16 lbs., and projectiles of 100 lbs. weight. At the 750th round, a crack was observed passing from the bottom of the bore in the direction of the muzzle about 1 inch to the right of the vent, and in the prolongation of the upper groove of rifling; 50 rounds

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were then fired without causing much apparent change in the character of the crack, completing in all 800 rounds.

"The A tube is split longitudinally and apparently through, in all about 33 inches in length.

"They (the Committee) are of opinion that the result of the trial is more favourable to the system than if the gun had fired a larger number of rounds and then burst with violence without giving warning. No rifled gun has as yet fired so many rounds with such large charges, and the accident which has led to the suspension of the experiment might to all appearance as well occur to the inner tube of any wrought iron gun. It is probable that the split was first caused by the groove becoming guttered, and that this guttering was accelerated by the use of the round-bottomed shells, a form which would favour the entry of the gas into the grooves before the shells had sensibly moved."

Now the truth of the conjecture of the Committee has since received abundant proof by the splitting of the barrels of several wrought-iron guns. The first instance being that of the steel barrel in the wrought-iron gun rifled on a similar plan, viz., the French system which split about six months afterwards.

I think that the importance of the performance of my gun in having fired 50 rounds with a split 33 inches long running down the powder chamber and through the inner, or A tube, cannot be too strongly dwelt upon. The A tube was subsequently removed by cutting three grooves quite through it. The three segments thus came away from the B tube, which although blackened and covered with dirt by the powder was ascertained to be quite uninjured. The experiment proved the great value of a thin A tube which prevents a crack from becoming deep, and also the value of a stout B tube to prevent explosive bursting when the inner tube shall have been destroyed by continuous firing. The fact of the 7-inch wrought-iron gun having repeatedly penetrated the Warrior Target with chilled white-iron shot and shell of 115 lbs. weight and only 13 lbs. of powder, and of the 6·3-inch wrought-iron gun having done so also with only 12 lbs. of powder, and an 80lbs. shot of the same kind, has added great importance to this experiment which took place three years ago.

My last experiment of endurance was made with a 32-pounder gun of 58 cwt. This gun was one of 8, which on the proposal of General Lefroy, President of the Select Committee, were converted by Sir W. Armstrong and Co., into 64 and 56-pounder rifled guns on my plans, in order to determine various details in rifling, amount of charge, sighting, etc., previous to their introduction into the service. These guns have all got a hole through the cascable—a plan of Sir William Armstrong—for the purpose of giving intimation of any escape of gas. The guns were all converted by this firm, and I have to acknowledge the friendly and valuable assistance they have afforded me. An escape of gas was observed at proof through the breech of one of these guns, and it was in consequence rejected. I have no doubt, that had I asked to be allowed to remedy this defect, my request would have been granted, but since for the sake of economy some alterations had been made in the manufacture I had previously adopted in the 7-inch gun, I was

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anxious to test this gun to destruction, and I therefore
Before describing its test I may mention that the servic
similar guns will probably be between 6½ and 8 lbs. of
common shell of 64 lbs. weight, and that they will ha
charges of probably 14 lbs. of powder I mention this t
to estimate the severity of the test, which was as follows
16 lbs. powder and 150 lbs. shot; 10 rounds, 20 lbs., 100
rounds, 10 lbs., and 5 rounds 16 lbs. of powder and
These shells were purposely burst in the gun; they wer
4½ lbs. of powder, their fuzes were taken out, and they
with their fuze holes towards the powder. The flash of t
thus entered the shell and burst it in the gun. The effe
explosions were merely to scratch and scrape the bor
places but they did not in any way interfere with subseq
of loading. Next 10 rounds, 16 lbs. of powder and sh
rammed down only so far as to leave air spaces between
and shot varying from 5 inches to 25 inches in length. T
produced no apparent effect, 71 rounds were then fired with
50, 100, 150 lbs. weight, and charges 10, 15, 25 and 30 lbs
At last the gun failed under a charge of 30 lbs., and a cyli
lbs. weight. The casing cracked but no explosive burst oc
gun was then cut open and it was ascertained that th
iron barrel was quite sound although considerably bulg
mention that the fore-sight was screwed through the
caused a large hole in it. The great length of the
ridge brought the strain under the fore-sight where t
the gun was also reduced in thickness, and the casing s
this hole.

In judging of these tests the strength of our English po
not be lost sight of; for most of the cast-iron guns whic
viously rifled, burst with a very limited number of rounds, w
varying from only 5 to 8 lbs. of powder, and shot of betw
65 lbs. weight. Most of these guns were supplied by t
Company; I understand, however, that the Italians fire
powder, and rifled steel shot of 110 lbs. weight from similarly
iron guns of the same calibre which they also obtained fro
It is certain that one such charge of our English powder
them to pieces. I do not mean to infer that the Italians,
Americans could not make as strong and even stronger p
ours, but the fact is that since they do not possess such s
as ours, they simply use a weaker powder which is sui
capabilities of their ordnance.

The bursting of so many cast-iron rifled guns with
charges, had naturally caused great distrust in this coun
employment of that material, and I have in consequence h
come a very strong prejudice. I am anxious, however, to in
this Meeting, 1stly, that the guns which I advocate are not st
cast-iron guns and that they should be designated coiled wi
guns encased in cast iron; 2ndly, that the interior or heart
is of vital importance, and that if this be composed of coile

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iron it matters but little whether the outside be composed of wrought-iron, steel, or cast iron.

I shall trouble you with only a few words upon the method of constructing new guns, which I think can be done in the cheapest as well as the quickest manner by running the metal round the barrels. It has taken many years and required many careful experiments to enable me to ascertain the various causes of unsoundness to which this mode of manufacture is liable, but I think I may say with confidence that they have now been all completely overcome. This small gun is a specimen of one nature of unsoundness. Here is another in which the tube is quite loose inside the casing. This section of a gun illustrates the fact of these difficulties having been overcome. It is 3 inches in bore and weighs 8 cwt., and is similar in these respects to the 12-pounder field gun of the service. The following is an extract from a letter I received from the Ordnance Select Committee, dated March 3, 1865, relative to its trial:—

"The test of your 3-inch compound gun has been completed, and the "gun remains apparently unaltered. It has fired—

	Cylinder's weight.
"10 rounds, charge 1¼ lbs.	24 lbs.
"10 ,, ,, ,, ...	48 lbs.
"10 ,, ,, ,, ...	72 lbs.
"20 ,, ,, ,, ...	96 lbs."

This* gun was subsequently bisected and you will notice that the mechanical fit of the cast-iron casing round the wrought-iron barrel is quite perfect.

My latest experiment in connection with this mode of construction has been with a 9-inch muzzle-loading gun rifled on the "Woolwich" system. The gun was made for me by Sir W. Armstrong and Co. The manufacture of the wrought-iron portion was carried out by Mr. George Rendel, and the casting was performed by Captain Noble. The successful issue is in a great measure due to the care and skill with which those gentlemen carried out the operation. The gun was first tested at Woolwich in a smooth-bore state by firing 20 rounds with cylinders of 250 lbs. weight. The first 18 rounds being with 43 lbs., and the last two with 55-lb. charges of powder. It was then sent back to Elswick and rifled on the Woolwich system, and on its return to Woolwich it was again proved with two rounds of 55 lbs. of powder and shot of 250 lbs. weight, and then completed the programme allotted to it, of 87 rounds of 45 lbs. powder and 250 lbs. shot. It so happened that the inner barrel of this gun was very defective, although it is right to state, that it is the only defective barrel out of upwards of a dozen which the Elswick Ordnance Company have made for my guns.

The mode in which a coiled barrel is made is as follows;—a bar of iron is wound round a mandril, and then welded into a tube about 18 inches long; a certain number of these lengths are then welded

* This gun is now in the Museum of the Institution.—Ed.

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together end to end, and form the barrel. The coils which formed the second length at the breech end of this barrel were imperfectly welded, and in consequence were separated one from another. Still very little apparent change was caused in these flaws by the test to which the gun was subjected, and I submit that the success of a gun, whose barrel was full of flaws in the powder-chamber, argues well for the success of similar guns when lined with sound barrels. Further, I think it will be conceded that having made and successfully fired a 9-inch gun with charges of 45 lbs. of powder, I have proved *à fortiori*, that 8-inch and 7-inch guns which fire respectively battering charges of only 30 and 22 lbs. of powder, as well as the great majority of our guns which are of smaller calibres, which fire smaller charges, and which are therefore exposed to lesser strains, can all be constructed upon the same system.

I have since sent the 9-inch gun to the Paris Exhibition, as I am anxious that it should be publicly recorded that the first large rifled gun constructed on a principle which I feel confident will shortly become universal, was made in this country.

There are two ways in which a gun can be burst, viz.,—by the bursting of the barrel or by the end being blown off. I have hitherto treated of the first mode of bursting, and I shall now say a few words on the second. In an ordinary cast-iron gun, the whole longitudinal pressure acts upon the end of the bore; if the bore be 8 inches in diameter, this pressure will, in round numbers, be distributed upon 50 square inches; if, however, the gun be bored up to 13 inches and lined with a barrel 2½ inches thick, the longitudinal pressure will act upon 50 square inches as before, but it will be transferred to a surface of about 130 square inches, and thus the longitudinal strength of the gun becomes more than doubled. In fact every way of regarding the subject shows that the circumferential strength should be applied internally, and that the longitudinal strength should be borne by the outside, and this is precisely the reverse of the principle on which the wrought-iron guns of the service are made.

Care must be taken that there be no sudden alteration of figure, or rather, that the longitudinal strength be not suddenly weakened at any one place. The method at first pursued in the construction of muzzle-loading wrought-iron guns, was to introduce the interior barrel through the breech piece and then screw in the breech plug or cascable behind it. It will be evident that the plug to close the hole, must be larger than the barrel which passed through that hole, and in consequence that the screw thread to receive that plug or cascable had to be cut *out* of the substance of the gun. This arrangement defined a markedly weak place in the breech of the gun. Now, had the breech to sustain only a statical or gradually applied pressure, this diminution of longitudinal strength would not have been of the slightest importance. When, however, the pressure becomes a blow more sudden and more rapidly applied than any which we can conceive a hammer to give, this difference of strength leads to fatal consequences. I shall endeavour to illustrate this fact by applying sudden or impulsive pressure to some screw bolts. Some of these are made in the ordinary manner, *i.e.*, the

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screw thread is cut out of the substance of the bolt, others have screw threads in relief upon the shank like the bolts which I proposed for the attachment of armour plates.

[Major Palliser here placed on the table an iron apparatus, in the form of a tripod, with a vertical rod suspended from the apex, up and down which a perforated mass of iron, weighing about a quarter of a cwt., could move freely. He then produced two bolts, and went on to say:—

"This one is an ordinary screw bolt such as is in general use. It "is a bar of iron tapped at the end. It screws into this nut. The "other bolt is tapped with the same screw tap, but it differs from the "first in this respect, that the shank of the bolt is reduced until the "thread is left in relief upon it. Now, if these two screw bolts were "subjected to a gradually applied pressure, the result would be, that "the first bolt would bear a greater weight than the other, inasmuch "as the sectional area of the screwed part is somewhat larger than "the sectional area of the reduced part. I shall try the ordinary bolt, "subjected to a sudden pressure, and if I am not mistaken, the "weight falling upon it will break it off at once at the screw part."

Major Palliser here screwed the bolt on to the lower end of the vertical rod, and allowed the weight to fall upon it suddenly, the result was that the nut was broken off by the shock. A second experiment with the same description of bolt was attended with a similar result. He then tried the second description of bolt, the bolt with the reduced shank, and the effect was very different. Instead of breaking off under the violence of the blow the iron was simply drawn out, and the blow being repeated several times, the shank became so weak that, at last, it broke in two at the thinnest part.]

I submitted the results of similar experiments to the Select Committee in the early part of 1863, and the original method of closing the breeches of the muzzle-loading guns, has in consequence been altered by them, and inner tubes have ever since been inserted into wrought-iron guns from the front.

III. *Chilled White-Iron Projectiles.*

This small target (Plate viii, fig. 10), is the one upon which I made my first experiments with chilled shot. This is the gun from which they were fired, and these are some of the shot themselves. I am afraid I have already detained you too long and shall therefore only say a few words more. The bore of the gun is ¾ inch in diameter. The target is composed of a wood backing three inches thick faced with two wrought-iron plates, the upper one ½, the lower one ¾ inch thick. The plates are secured with through bolts reduced in their shanks to the lesser diameter of the screwed part. The gun thus represented to scale ¼ a sixty-eight pounder converted into a 6 inch rifle gun, and the target represented to the same scale, 24 inches of wood backing faced with plates respectively 4 and 6 inches thick. The experiments were made in Woolwich Arsenal. The projectiles weighed 5¼ ounces each.

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Date of Firing.	Number of Round. *See* Pl. viii, Fig. 10.	Charge in Ounces.	Thickness of Plate.	Nature of Projectiles.	Resul
1863			Inch		
May 14th	1	1	½	Wrought-iron Shot, faced with steel; conical head	Penetrated Plate only
,,	2	,,	½	Wrought-iron Shot, round head	Plate indented.
,,	3	1½	¾	Wrought-iron Shot, faced with steel, flat head	Plate indented; mark in Plate. (*See* fig.
,,	4	,,	¾	Wrought-iron Shot, round head	Plate slightly indent plate. ix.)
,,	5	,,	½	Wrought-iron Shot, round head	Plate indented.
,,	6	,,	½	Wrought-iron Shot, faced with steel, conical head	Penetrated Plate onl
May 21st	7	1	½	White-iron chilled Shot, conoidal head	Target completely pe was subsequently d in rear. It was q shape, with exceptio (to receive the lead) (*See* figs. 13 and 14
,,	8	,,	½ & ¾	White-iron chilled Shot, conoidal head	Struck on edge of glanced; deep inde
,,	9	,,	¾	White-iron chilled Shot, conoidal head	Penetrated Plate only Shot, which was subse was perfect. (*See* fi
,,	10	,,	½	White-iron chilled Shot, flat head	Penetrated Plate onl pieces.
,,	11	1½	¾	White-iron chilled Shot, conoidal head	Penetrated Plate only Shot, which was subse was perfect.
May 25th	12	1	¾	Wrought-iron Shot with steel ring in front, flat head.	Indented the Plate steel ring. (*See* fig.
,,	13	,,	¾	White-iron chilled Shot, flat-headed	Shot broke into pieces which it slightly ind
,,	14	,,	½	White-iron chilled Shot, flat-headed	Penetrated Plate only
,,	15	,,	½	White-iron chilled Shot, conoidal head	Penetrated Target co was subsequently d in rear. It was q shape, with exceptic (to receive the lead) off. (*See* fig. 18, pl

In considering the relative effects of the several Projectiles, particular att
to the thickness of the Plate which was struck.

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The result of this experiment showed me that a penetration at all events equal to that of any steel could be obtained by the use of *conical-headed* chilled shot, could those of the larger sizes be rendered as hard by the chilling process as these small ones had been made. On the 12th and 13th of November, 1863, some ogival-headed chilled shot and shell (for shape of head see Fig. 19, Plate ix) were fired from a 12-pounder breech-loading gun against 2½-inch plates at Shoeburyness. The results, although they surprised others who were present at the experiment, disappointed me, and I at once perceived that the iron which had answered so well in the very small shot, was not suited to those of larger natures. On my return to my regiment at Norwich, I made a series of experiments at Messrs. Riches and Watts' foundry there, until I obtained large shot of precisely the same nature as the small ones, viz., of chilled white iron. I now, however, encountered a serious difficulty. The Ordnance Select Committee having hitherto carried out all the competitive trials of the steel shot of various makers from the 7-inch breech-loading gun of the Service, it was determined to continue the experiments with my shot from the same gun for the purpose of obtaining comparable results. We now found that the chilled white-iron shot cracked and fell into pieces during the process of lead coating, for the sudden and great changes of temperature, necessitated thereby, split the highly tempered mass, as hot water does a glass. We therefore had to institute the most careful experiments in the Royal Laboratory until we got a shot hard enough to penetrate and yet soft enough not to crack in leading.

From the time, however, that I was allowed to fire shot from the muzzle-loading gun, all my difficulties ceased.

Fig. 19, Plate ix, is a copy of a photograph of the head of a 12-pr. chilled white-iron shot, which penetrated a 2½-inch plate and buried itself 2 feet 8 inches in the earth in rear, on the 29th September, 1864. Fig. 20 is a copy of a photograph of a 7-inch shell, which, filled with sand, weighed 115 lbs., and fired at 70 yards distance with a reduced charge of 13 lbs. of powder, completely penetrated "the 'Warrior' target." Fig. 21 is a copy of a photograph of a 9-inch shell, weight 250 lbs., which, with a charge of 23 lbs. of powder, and fired at an angle of 74°, penetrated "the 'Warrior' target" at 200 yards distance, and burst after penetration. The full charges of the 7 and 9-inch rifle guns being respectively 22 lbs. and 43 lbs., the reduced charges of 12 lbs. and 23 lbs. were calculated to represent a distance of upwards of 1½ miles.

The following table shows the relative powers of penetration of various natures of projectiles referred to the "Warrior" target as a standard:—

None of these did penetrate the "Warrior" Target at 200 yards.

- 10½-inch cast-iron round shot of 150 lbs. fired with 50 lbs. of powder.
- 9-inch steel round shot of 115 lbs. fired with 25 lbs. of powder.
- 7-inch steel shell round-headed of 100 lbs. fired with 25 lbs. of powder.

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These have penetrated the "Warrior" at 200 yards.
- 7-inch ogival-headed white-iron chilled shot or shell, fired with any charge from the service battering charge of 22 lbs. down to one of 13 lbs. inclusive.
- 6·3-inch chilled shot and shell of 80 lbs. fired with 14 lbs., or even 12½ lbs.

In conclusion I would observe that I have no personal interest whatever in penetrating anybody's target, and that so long as my projectiles make deeper indents than those made by any other projectiles, I am perfectly satisfied, so far as I am myself concerned. On public grounds, however, I hold it to be a source of satisfaction that the guns have beaten the targets. I am of opinion that the more destructive weapons of offence become as compared with moveable appliances for affording immediate protection, the greater will be the superiority of those acting on the defence, and *vice versâ*. I believe this theory is quite general, whether applied to a few men armed with that destructive weapon of offence, the Snider breech-loader, defending themselves under cover of a parapet from the attack of superior numbers advancing across the open, or to the regular attack and defence of fortresses,* or to the attack of armour-plated ships upon coast defences.

As the question at present stands, our rifled cannon could easily beat off the attack of an iron-clad fleet upon any of our maritime fortresses, but should protective appliances be able to defy those of offence, iron-clad ships would be enabled, during any temporary absence of our own fleet, to bombard in security, and at their leisure, those dockyards and fortresses, such as Malta, Portsmouth, and Gibraltar, which lie on the sea coast.

Looking to the great wealth of this country, our extended commerce and isolated position, it will, I think, be admitted that any war in which we may have the misfortune hereafter to be engaged, will most probably be a war of defence on our part, and therefore anything that conduces to the efficiency of defensive warfare, will contribute to the security and welfare of this country.

APPENDIX.

ANDREW HART, LL.D., Senior Fellow Trinity College, Dublin, and the Rev. JOHN TWISDEN, M.A., Professor of Mathematics, contributed the following mathematical papers to my Treatise on Compound Ordnance in 1862.

* Colonel Sir William Denison, K.C.B., R. E., in a letter to Colonel Harness, C.B. R.E., "On the influence of rifled cannon, and small arms on the Attack and Defence," (Professional papers of the corps of Royal Engineers, vol. xii, page 4), says "it is needless to press the comparison farther; it appears to me that the balance of advantage preponderates on the side of the defence; that the siege of any given place would take longer time under existing circumstances, than when the arms used were the musket and the 24-pounder, and the loss to the besieger would be greater."—W.P.

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Dr. Hart's Investigations.

This formula of Barlow rests on the assumption that the area of each transverse section is unchanged by internal pressure; in other words, that no transverse pressure applied to iron will alter either its density or its length, or, at least, that one of these effects will so far counteract the other as to leave the area of the transverse section unchanged. As a general proposition, this is (to say the least) highly improbable; and although in the particular case of the cylinder it may be nearly true, yet it should not be assumed as an axiom.

The more commonly received theory is, that the extension or compression of iron in any direction is proportional to the force which acts in that direction; and the following calculation, which I made some years ago, is based on that theory. The result, as will be seen, is that the strain on any lamina of the cylinder is to the strain on the external lamina as the sum of the squares of the diameters of the two laminæ to double the square of the diameter of the smaller one.

Let r be the radius of one of the cylindrical laminæ of which the tube is composed, and let dr be its thickness (the length of the tube being unity); also let p be the total internal pressure on this lamina, and $p—dp$ the reaction of the lamina immediately exterior to it. It is obvious that the difference of these two forces tends to stretch the laminæ, and therefore to increase its radius. Let δr be the extension of the radius, and k the modulus of elasticity (or the ratio of the extending force to the extension), and we have

$$\frac{dp}{2\pi\, dr} = k\frac{\delta r}{r} \qquad (1)$$

But since this same lamina is compressed in the direction of its thickness by the two opposing forces p and $p—dp$, its thickness will be reduced by a quantity $d\delta r$ proportional to the compressing force; that is to say,

$$\frac{p}{2\pi\, r} = k\,\frac{d\delta r}{dr} \qquad 2)$$

(I assume that the modulus of the resistance to compression is equal to that of resistance to extension.)

Multiplying these two equations, we get—

$$\frac{p\, dp}{4\pi^2} = k^2\, \delta r.\, d\delta r \qquad (3)$$

Whence, by integration, if R be the radius of the external surface where $p = o$

$$\frac{p^2}{4\pi^2} = k^2\, \{(\delta r)^2 - (\delta_R)^2\} \qquad (4)$$

and, eliminating p between equations (2) and (4)—

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$$\frac{d\delta r}{\{(\delta r)^2-(\delta R)^2\}^{\frac{1}{2}}}=\frac{dr}{r}$$

whence, by a second integration—

$$\delta r-\sqrt{(\delta r)^2-(\delta R)^2}=cr$$

and, eliminating c by the condition that when $r=R$, $\delta r=\delta R$, we have finally—

$$\frac{\delta r}{\delta R}=\tfrac{1}{2}\frac{r}{R}+\tfrac{1}{2}\frac{R}{r}=\frac{R^2+r^2}{2Rr} \qquad (5)$$

that is to say, the extension of any lamina is to the extension of the external surface as the sum of the squares of the radii to double their product; but the strains are proportional to the extensions divided by the lengths, that is, as the sum of the squares of the radii to double the square of the lesser radius r. Q.E.D.

In this reasoning it is assumed that the normal compression and the tangential extension are each proportional to the force which acts in its direction, and that a compression or extension in one direction does not cause any change of dimensions in a direction perpendicular to the force. This is manifestly false in ductile bodies, and is probably inaccurate even within the limits of elasticity. This error, however, is in the opposite direction to that of Barlow, before alluded to, and it is probable that the true law is intermediate between the two hypotheses, and that so far as they agree in results they may be safely relied on.

Returning to the equations, we find, by elimination between (4) and (5), and supposing r to be the radius of the inner surface of the tube, that the total internal pressure is

$$p=2\pi k\,\frac{R^2-r^2}{R^2+r^2}\,\delta r$$

and as fracture will take place as soon as $\frac{\delta r}{r}$ reaches a certain limit F, it follows that the total internal pressure must be less than

$$2\pi r\,EF\frac{R^2-r^2}{R^2+r^2} \qquad (6)$$

or that the pressure per square inch must be le less than

$$EF\frac{R^2-r^2}{R^2+r^2}$$

where it is also to be observed, that the value of k is probably less than the coefficient of elasticity given in the tables, on account of the error in the hypothesis which I have already mentioned. Differentiating the expression (6), we find the condition that a tube of given external diameter shall sustain the greatest possible amount of internal pressure, viz.—

$$R^4-4R^2r^2-r^4=0$$

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whence

$$\frac{r}{R} = (\sqrt{5} - 2)^{\frac{1}{2}} = \cdot 486$$

If one cylinder be inserted into another so as to fit accurately without initial pressure, and if r' be the radius of the surface of contact, and k, k' the moduli of elasticity of the outer and inner cylinders, then it is clear that the state of tension of the inner cylinder will depend on the pressure at the surface of contact, which is $2\pi k \frac{R^2 - r'^2}{R^2 + r'^2} \delta r'$; and that it will be unaltered by changing k and R to k' and R'. provided that $k' \frac{R'^2 - r'^2}{R'^2 + r'^2}$ retains its value; that is to say, if

$$R'^2 = \frac{(k' + k)\ R^2 + (k' - k)\ r'^2}{(k' + k)\ r'^2 + (k' - k) R^2} r'^2$$

Accordingly the strength of the compound tube will be the same as of a simple tube composed of the inner material, with an external radius equal to the above value of R', *observing that* $\frac{\delta r}{r}$ *must not exceed the limit of elasticity of the inner tube, and that* $\frac{\delta r'}{r'}$ *which is similarly determined, must not exceed that of the outer tube.*

Revd. John Twisden's Investigations.

There are two ways in which a gun may be destroyed—viz., by the bursting of the barrel, or by the end being blown off.

I shall in the first place, consider the former of these, reserving for another place my remarks on the latter.

The force by which the shot is propelled and the gun destroyed, if it be destroyed, is the pressure due to the expansion of the gases formed by the ignition of the gunpowder; and this pressure must be of the same nature as that produced by any other gas in a state of compression; but its capacity to destroy the gun will be affected by its sudden application, by the rapid change it undergoes in magnitude, owing to its expansion, and by the shortness of the time during which its action continued.

The first point for investigation is this:—Given a cylinder filled with a fluid and subjected to a pressure of P lbs. per square inch to determine the strain and the enlargement of the radius caused by that pressure at any point of the substance of the cylinder: for the sake of distinctness, we shall consider a portion of the cylinder whose axis is one inch long.*

* In this investigation, it is supposed that, where the gun consists of two concentric cylinders, they fit exactly, but neither exercises any strain on the other, except when it is subjected to internal pressure.

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(1) If we suppose the internal radius of the cylinder to be r, and the thickness of its substance to be very small, then it is well known that, if any small portion of it be taken, it is stretched by two opposite tangential forces whose ultimate value T is given by the equation

$$T = Pr \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and if δr is the increase of the radius due to P, we have

$$\frac{\delta r}{r} = \frac{Pr}{Et} \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where E is the modulus of elasticity and t the thickness of the cylinder, or the difference between its external and internal radii.

(2) Now let us suppose the external radius (R) to differ sensibly from the internal radius (r), but the substance of the cylinder to consist of one homogeneous material: conceive the substance to be made up of an indefinitely great number of cylindrical laminæ; let ρ, and $\rho + d\rho$ be the internal and external radii of one of these laminæ, and let π be the pressure per square inch transmitted to its interior surface, then part of π will be transmitted to the next lamina, and part will be employed in stretching the lamina thus increasing its internal radius from ρ to $\rho + \delta\rho$, let $\pi + d\pi$ be the pressure per square inch transmitted to the next lamina. Now $\pi + d\pi$ being spread over a larger area will be equivalent to $(\pi + d\pi)\frac{\rho + d\rho}{\rho}$ on the inner surface of the lamina, and therefore the part of π employed in stretching the lamina is

$$\pi - (\pi + d\pi)\frac{\rho + d\rho}{\rho};$$

and therefore the tension of that lamina (by equation 1) is

$$\pi\rho - (\pi + d\pi)(\rho + d\rho)$$

which ultimately equals

$$-(\rho d\pi + \pi d\rho)$$

or

$$-d.\ \pi\rho$$

Hence by equation (2) observing that $t = d\rho$, we have

$$-\frac{d.\ \pi\rho}{E.\ d\rho} = \frac{\delta\rho}{\rho} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Now if all the radii of the laminæ were enlarged by the same amount, the external radius would become

$$\rho + d\rho + \delta\rho$$

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But if there is any variation in the enlargement of the several radii, it would become

$$\rho + d\rho + \delta\rho + d.\,\delta\rho$$

Now each lamina is compressed by the pressure transmitted to it; consequently

$$d.\,\delta\rho = -\frac{\pi d\rho}{\mathrm{E}} \quad . \quad . \quad . \quad . \quad (4)$$

By multiplying (3) and (4) we obtain

$$\pi\rho d.\,\pi\rho - \mathrm{E}^2\,\delta\rho d.\,\delta\rho$$

$$\therefore (\pi\rho)^2 = \mathrm{E}^2(\delta\rho)^2 + \mathrm{c}$$

but when $\rho = \mathrm{R}$, $\pi = 0$ and $\delta\rho = \delta\,\mathrm{R}$

$$\therefore (\pi\rho)^2 = \mathrm{E}^2\Big((\delta\rho)^2 - (\delta_{\mathrm{R}})^2\Big)^2 \quad . \quad . \quad . \quad (5)$$

Eliminate π between (4) and (5), and we obtain

$$\frac{d.\,\delta\rho}{\sqrt{(\delta\rho)^2 - (\delta_{\mathrm{R}})^2}} = \frac{d\rho}{\rho}$$

Integrating, and remembering that when $\rho = \mathrm{R}$, $\delta\rho = \delta_{\mathrm{R}}$, we have*

$$\frac{\delta\rho}{\delta_{\mathrm{R}}} = \frac{1}{2}\left(\frac{\rho}{\mathrm{R}} + \frac{\mathrm{R}}{\rho}\right) \quad . \quad . \quad . \quad . \quad (6)$$

Eliminating $\delta\rho$ from (5) and (6), we obtain

$$\pi\rho = \frac{\mathrm{E}\delta_{\mathrm{R}}}{2}\left(\frac{\mathrm{R}}{\rho} + \frac{\rho}{\mathrm{R}}\right) \quad . \quad . \quad . \quad . \quad (7)$$

Now let δr be the extension of the inmost lamina we have from (6)

$$\delta r = \frac{\delta_{\mathrm{R}}}{2} \cdot \left(\frac{\mathrm{R}}{r} - \frac{r}{\mathrm{R}}\right) \quad . \quad . \quad . \quad (8)$$

and

$$\mathrm{P}r = \frac{\mathrm{E}\delta_{\mathrm{R}}}{2}\left(\frac{\mathrm{R}}{r} - \frac{r}{\mathrm{R}}\right)$$

therefore eliminating $\mathrm{R}\delta$, we obtain

$$\mathrm{P} = \frac{\mathrm{E}\delta r}{r}\left(\frac{\mathrm{R}^2 - r^2}{\mathrm{R}^2 + r^2}\right) \quad . \quad . \quad . \quad . \quad . \quad (9)$$

(3) The more usual method of treating the question is, to neglect the compression and to consider that the total area of the transverse

* Formula (6) was communicated by A. S. Hart, Esq.

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section of the metal undergoes no change; under these circumstances equation (3) remains the same, but instead of equation (4) we obtain

$$\rho d.\delta\rho + d\rho\delta\rho = 0$$

or,

$$d.\rho\ \delta\rho = 0 \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

If we treat these fundamental formulæ in a similar manner, the following equations can be obtained—viz.,

$$r\delta r = \rho\delta\rho = R\delta R \quad . \quad . \quad . \quad . \quad . \quad (11)$$

$$\pi\rho = Er\delta r\left(\frac{1}{\rho} - \frac{1}{R}\right) \quad . \quad . \quad . \quad . \quad (12)$$

$$P = E\delta r\left(\frac{1}{r} - \frac{1}{R}\right) \quad . \quad . \quad . \quad . \quad (13)$$

It will be remarked that the two methods of treating the question (which I shall henceforth speak of as Hart's and Barlow's respectively) lead to different numerical results, but the truth is probably between the two; hence any conclusion to which they both unmistakeably point may be unreservedly accepted.

(4) I shall, in the first instance, apply them to show the serious loss of strength involved in the construction of a gun of homogeneous metal. For this purpose consider the inmost and any other lamina, and suppose the inmost to be stretched to the utmost extent consistent with safety, then if we had

$$\frac{\delta r}{r} = \frac{\delta\rho}{\rho}$$

the second lamina would also be stretched as far as is consistent with safety; if this were the case, all the laminæ would be on the point of yielding at the same instant, and no part would then be unnecessarily strong. But this is very far from being the case, and it will be found from Barlow's formula (11) that

$$\frac{\delta\rho}{\rho} = \frac{r^2}{\rho^2} \cdot \frac{\delta r}{r} \quad . \quad . \quad . \quad . \quad . \quad (14)$$

To obtain a similar formula from Hart's principles. Eliminate δR between (6) and (8), and we obtain

$$\frac{\delta\rho}{\rho} = \frac{r^2}{\rho^2}\,\frac{R^2+\rho^2}{R^2+r^2} \cdot \frac{\delta r}{r} \quad . \quad . \quad . \quad . \quad (15)$$

Take a gun of 6-inch calibre and 10 inches of metal, and consider the laminæ whose respective radii are 3, 4, 5 . . . 13 in.

Then, according to Barlow, if the first is strained as far as it can be with safety, the second will only bear $\frac{9}{16}$ of what it can with safety, and the others in order $\frac{9}{25}$, $\frac{9}{36}$, $\frac{9}{49}$, $\frac{9}{64}$, $\frac{9}{81}$, $\frac{9}{100}$, $\frac{9}{121}$, $\frac{9}{144}$, $\frac{9}{169}$, of what they are capable of bearing. According to Hart, these numbers would

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be $\frac{9}{10}(1+\frac{7}{178})$, $\frac{9}{25}(1+\frac{16}{178})$, $\frac{9}{36}(1+\frac{27}{178})$, $\frac{9}{49}(1+\frac{40}{178})$, $\frac{9}{64}(1+\frac{55}{178})$, $\frac{9}{81}(1+\frac{72}{178})$, $\frac{9}{100}(1+\frac{91}{178})$, $\frac{9}{121}(1+\frac{112}{178})$, $\frac{9}{144}(1+\frac{135}{178})$, $\frac{9}{169}(1+\frac{160}{178})$.

It is plain from both these series of numbers that, when the inmost lamina is stretched as much as is consistent with safety, the lamina which is only two inches farther from the centre is only stretched the $\frac{9}{25}$ or $\frac{9}{25}(1+\frac{16}{178})$, say about $\frac{3}{4}$th of what it can be stretched with safety, while those near the outside of the gun are not stretched $\frac{1}{10}$th or $\frac{1}{13}$th part as much as they might be stretched with with safety, and all their remaining strength is useless.

It may be remarked that the factor in Hart's formula, $\frac{R^2+\rho^2}{R^2+r^2}$ will be but little greater than unity for the laminæ near the bore, and, since ρ must be less than R, must always be less than 2; from hence it will follow that the strain on the successive laminæ is distributed very nearly according to Barlow's formula.

(5) There is another conclusion deducible from Barlow's formula. Let us suppose the bore of the gun to be increased till its radius is x, and suppose the metal removed to be replaced by an incompressible substance which offers no resistance whatever to extension; under these circumstances the force of the explosion is the same as before, and it is now supported by the part of the iron that has been left; and it can be easily proved that the gun will be stronger than it was before, so long as the remaining thickness of the iron is greater than the radius of the bore.

Since the lining transmits the pressure after the manner of a solid, the pressure per square inch on the internal surface of the iron is reduced to $\frac{Pr}{x}$, hence from formula (13) we obtain

$$\frac{Pr}{x} = \frac{E\delta x}{x}\left(\frac{1}{x}-\frac{1}{R}\right) \quad . \quad . \quad . \quad . \quad (16)$$

Now the ultimate strength of a gun is measured by the pressure which stretches the inmost lamina to the bursting point; hence if P' and P'' are the ultimate strengths of the two guns, P' will be the value of P from equation (13), when

$$\frac{E\delta r}{r} = T$$

the tenacity, and P'' the value of P from equation (16), for which

$$\frac{E\delta x}{x} = T;$$

hence

$$P' = T.\ \frac{R-r}{R}$$

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and

$$\frac{P'' r}{x} = T \frac{R-x}{R}$$

therefore

$$\frac{P'}{tP} = \frac{x(R-x)}{r(R-r)}$$

and $P'' > P'$ so long as $Rx - x^2 > Rr - r^2$, or so long as x is less than $R - r$. The value of x for which P'' is the greatest possible, is clearly $\frac{1}{2}$ R. *If it were possible to remove the iron from the interior of the gun above cited, and replace it in the manner proposed, the gun would be as strong with only* 3 *inches of iron as it was with* 10 *inches, and with* $6\frac{1}{2}$ *inches of iron it would be stronger than with* 10 *inches in the proportion of about* 7 : 5, i.e., *according to Barlow's formula. If Hart's formulæ are employed, similar results,* though much more complicated, are obtained—which in the case of the gun cited lead to a nearly identical result, viz., that the gun is stronger with any thickness of metal not less than* 3·2 *inches, and is strongest when its thickness is reduced to* 6·32 *inches.*

(6) The foregoing investigation is based upon a supposition which can never be realised, viz., that the lining of the gun is an incompressible solid, and one that offers no resistance to extension. We will now examine the case in which the gun consists of two cylinders, one fitting the other exactly; we will denote by r' the internal radius of the outer cylinder, by E' and E'' the moduli of elasticity of the inner and outer cylinder respectively, and we will use the same notation in other respects as before.

We will treat this question on Barlow's principle, *i.e.*, we shall have the two fundamental equations.

$$\rho\delta\rho = r\delta r = r'\delta r' = R\delta R$$

and

$$-\frac{d\pi\rho}{d\rho} = E'\frac{r\delta r}{\rho^2}$$

integrating and remembering that

$$\pi = P \text{ when } \rho = r$$

we have

$$Pr - \pi\rho = Er\delta r\left(\frac{1}{r} - \frac{1}{\rho}\right)$$

* If the internal radius of the original gun is increased to x, the gun will be strengthened so long as

$$x(R^2 + r^2) < R\left\{\sqrt{R^4 + R^2 r^2 - r^4} - Rr\right\}$$

and its strength is greatest when

$$x = 0{\cdot}485\ R$$

i.e., according to Hart's principle.

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whence, if P′ is the pressure per square inch transmitted to the inner surface of the outer cylinder, we have

$$Pr - P'r' = E'r\delta r\left(\frac{1}{r} - \frac{1}{r'}\right)$$

But equation (13) gives us, remembering that $r\delta r' = r'\delta r$

$$P'r' = E''r\delta r\left(\frac{1}{r'} - \frac{1}{R}\right)$$

and therefore

$$Pr = r\delta r\left\{E'\left(\frac{1}{r} - \frac{1}{r'}\right) + E''\left(\frac{1}{r'} - \frac{1}{R}\right)\right\} \qquad (17)$$

or

$$Pr = r'\delta r'\left\{E'\left(\frac{1}{r} - \frac{1}{r'}\right) + E''\left(\frac{1}{r'} - \frac{1}{R}\right)\right\} \qquad (18)$$

NOTE.—Deductions can be made from Hart's principle in a similar manner, but complicated equations are obtained.

This last equation will enable us to institute a direct comparison between the method of strengthening a gun by encasing it in wrought iron, and that which seeks to effect the same object, by lining it with wrought iron; the difference will be most conveniently exhibited by a numerical example.

(7) Take a cast-iron gun of calibre 6 inches and thickness of metal 10 inches, convert it into a gun whose calibre shall be 10 inches; required (1st) the thickness of the wrought-iron casing, (2nd) the thickness of the wrought-iron lining which must be applied, so that under the same internal pressure per square inch it may be as strong as it was before its calibre was enlarged.

For the sake of simplicity, I shall assume that the modulus of elasticity of wrought iron is double that of cast iron, which is, on the average, nearly the case.

(a) For the gun of 6 inches calibre we have (13)—

$$P = \frac{E\delta^2}{r}\left(\frac{R - r}{R}\right)$$

where $r = 3$ and $R = 13$; for the second gun we have (since $E'' = 2E' = 2E$) from (17)

$$P = \frac{E\delta r}{r} \cdot r\left\{\left(\frac{1}{r} - \frac{1}{r'}\right) + 2\left(\frac{1}{r'} - \frac{1}{R}\right)\right\}$$

where $r = 5$, $r' = 13$, and R is the external radius; now P and E are the same in both formulæ, and, the inmost lamina being of cast iron, the weakest point in both guns will be equally tried if $\frac{\delta r}{r}$ in both are equal. Now on substituting numerical values, the first formula gives

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$$P = \frac{E\delta r}{r} \cdot \frac{10}{13}$$

the second gives

$$P = \frac{E\delta r}{r} \cdot 5 \left(\frac{1}{5} + \frac{1}{13} - \frac{2}{R}\right)$$

Hence

$$\frac{10}{13} = 1 + \frac{5}{13} - \frac{10}{R}$$

$$\therefore \frac{10}{R} = \frac{8}{13} \text{ and } R = \frac{130}{8} = 16\tfrac{1}{4}$$

or the wrought-iron casing must be $3\frac{1}{4}$ inches thick.

(*b*) Let us suppose x to denote the external radius of the wrought-iron lining; in this case the condition of equal strength will be that the inmost lamina of cast iron shall be equally strained in both cases: hence, as before, we have for the first gun—

$$P = \frac{E\delta r}{r} \frac{10}{13}$$

and for the second gun—

$$Pr = x\delta x \left\{ E' \left(\frac{1}{r} - \frac{1}{x}\right) + E''\left(\frac{1}{x} - \frac{1}{R}\right)\right\}$$

were $r=5$, $R=13$ and $E'=2E''=2E$

$$\therefore P\ 5 = \frac{E\,\delta x}{x} \cdot x^2 \left\{ 2\left(\frac{1}{5} - \frac{1}{x}\right) + \frac{1}{x} - \frac{1}{13}\right\}$$

the condition of equal strength being

$$\frac{\delta r}{r} = \frac{\delta x}{x}$$

Hence we have for the determination of x the equation

$$x^2 \left(\frac{2}{5} - \frac{1}{x} - \frac{1}{13}\right) = \frac{50}{13}$$

$$\therefore x = 5{\cdot}33.$$

Whence the thickness of the iron lining is about $\frac{1}{3}$ of an inch. *A lining $\frac{1}{3}$ of an inch thick on the inside rendering the gun as strong as a casing $3\frac{1}{4}$-inch thick.*

If we solve the above question, supposing a is the internal and R the external radius of the original cast-iron gun, and if we suppose that the bore is to be increased to r, then if T is the thickness of the wrought-iron casing, we shall have

$$T = R\frac{r-a}{r+a} \quad . \quad . \quad . \quad . \quad . \quad . \quad 19)$$

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and if t is the thickness of the wrought-iron lining, a general value for t can be easily found, but it is complicated; however, in all practical cases we have very approximately*

$$t=(r-a)\frac{r}{3\text{R}-2r} \quad . \quad . \quad . \quad . \quad . \quad (20)$$

(8) I will now apply these formulæ to another case. Let there be a cast-iron gun whose internal radius is a, and external radius is R, and another gun consisting of a wrought-iron tube, whose internal and external radii are r and r' respectively placed inside a cast-iron gun whose internal and external radii are r' and R, required to compare their ultimate strengths. The ultimate strength of the former is attained when the inmost lamina is stretched by a force equal to its tenacity (T), *i.e.*, when

$$\frac{\text{E}\delta a}{a}=\text{T}$$

Since the tenacity of wrought iron is at least four times that of cast iron, it follows that unless the wrought-iron tube had a thickness of more than half the calibre, the train transmitted on the cast iron would produce rupture before the wrought iron yielded. Now the wrought-iron tubes suggested in the present paper would never attain this thickness: hence the ultimate strength of the second gun will be attained when the inmost lamina of the cast iron is subjected to a strain equal to its tenacity, *i.e.*, when

$$\frac{\text{E}\delta r'}{r'}=\text{T}$$

Hence if P and P′ are the internal pressures producing the ultimate strains in the two cases, we have from (13)

$$\text{P}=\text{T}\frac{\text{R}-a}{\text{R}} \quad . \quad . \quad . \quad . \quad . \quad .$$

and from (18), remembering that $\text{E}'=2\text{E}''=2\text{E}$

$$\text{P}'=\text{T}\frac{r'^2}{r}\left(\frac{2}{r}-\frac{1}{r'}-\frac{1}{\text{R}}\right)$$

Hence the ratio of their ultimate strengths is

$$\frac{\text{P}'}{\text{P}}=\left(\frac{r'}{r}\right)^2\frac{2\text{R}}{\text{R}-a}-\frac{r'}{r}\cdot\frac{\text{R}+r'}{\text{R}-a} \quad . \quad . \quad . \quad (21)$$

In this formula, since R is greater than r', and r' than r, it is plain that the first term will ordinarily be much larger than the second; *e.g.*, take

* If we use formula (20) in the above example we obtain $t=\frac{1}{3}$, the exact value being 0·33. An inspection of equations (19) and (20) will show that in all practical cases T must be many times greater than t.

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the cast-iron gun as before, and replace the inmost inch of metal by wrought iron, then $R = 13$, $r' = 4$, $r = a = 3$, and we shall find

$$P' : P :: 212 : 90;$$

or the mere substitution of one inch of wrought-iron for an inch of cast on the interior considerably more than doubles the strength of the gun.

If we enlarge the bore up to 13 inches, and then line it with wrought iron 1·5 inches thick, so that $R = 13$, $r' = 6{\cdot}5$, $r = 5$, $a = 3$ we shall find $P' = 1{\cdot}86\ P$, *or the gun's strength is nearly doubled, although its calibre is increased from* 6 *inches to* 10 *inches.*

It can be easily shown that, if a cast-iron gun is cased in wrought iron, whose external radius is R', the ratio of the ultimate strength of the gun will be given by the formula

$$\frac{P'}{P} = \frac{R}{R'} \cdot \frac{R' - r}{R - a} + \frac{r}{R'} \cdot \frac{R' - R}{R - a} \quad . \quad . \quad (22)$$

which shows that scarcely any thickness of wrought-iron casing will materially strengthen the gun; e.g. in the last example suppose the calibre increased to 10 inches, and the casing of wrought iron to be 4 inches thick, so that $R' = 17$, we shall find $P' : P :: 176 : 170$; or that the strength is scarcely increased. In fact if the thickness of the casing is infinitely great, $\frac{P'}{P}$ only equals $\frac{R + r}{R - a}$, which is never much greater than unity.

The CHAIRMAN: In this very interesting paper which you have heard from Major Palliser, there are doubtless many points upon which gentlemen present may wish to offer observations. All I would ask of you is, as the subject is a very wide one involving much detail, that you will be good enough to confine yourselves strictly to the subject of the paper.

Captain HARRISON, R.A.: There are two points in Major Palliser's interesting paper that it strikes me he did not allude to, and which, I think, are very important both as regards his system of guns and his system of projectiles. It is simply as to their relative cost. Major Palliser evidently, I think, proposes to utilise our cast-iron guns. We must take it for granted that his system will be infinitely cheaper than any system we have at present, if it is equally efficacious. But he also intimated that he proposed to make new guns on this principle. Now, I think it is very desirable, if Major Palliser can do so, that he should tell us what is the relative cost both of the conversion of our old cast-iron guns on the system he proposes, and also of making new guns on his principle. I think the same question applies to his very wonderful—I was going to say, discovery—it is hardly a discovery; but the success he has attained with these chilled projectiles, not only with shot but with shell, and the experiments with which, I have had the pleasure of witnessing from the very commencement, has been very great. He spoke of the satisfaction which everybody had at Shoeburyness, except himself, with the 12-lb. projectiles. I saw that experiment myself, and this is the first time I was at all aware that Major Palliser was dissatisfied. I can only say that if he was dissatisfied, I think he is very *exigeant*, because every one else present on the ground on that occasion was perfectly astonished; so much so, that it led at once to further experiments, which have gone on until the successful results that we see at the present time, have been attained. Not only have his projectiles supplanted steel shot, but we absolutely find, with

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regard to steel shell which were reported by the Iron-plate Committee as the only projectiles which were of use for attacking iron-clads, but which are of enormous cost even if we could obtain them of uniform quality, that we can now positively say that steel shell are no longer required, and that we shall simply have shell of chilled iron or white iron, whichever you may call it. But I think it is desirable that Major Palliser should tell us the relative cost of these projectiles; because, with the enormous number that will be required for this country, that becomes a very material question. There is only one other point which occurs to me; it is, that when Major Palliser began to show us that very striking experiment, with regard to the relative strength of those screw bolts, the result was so successful that it drove the thing out of his head, and he did not finish his explanation. Having also had the advantage of seeing the very earliest experiments with those bolts, which were originally submitted by Major Palliser to the Iron-plate Committee, and his earliest letter on the subject as recorded in the reports, I think that those bolts have not yet met with the reward that they deserve. For I must say that uninterruptedly they have been successful. I may be wrong, because I am not aware what decision has been come to, but I should be glad to hear that they have been adopted. The one objection that I have heard alleged against them is not a very strong one, which is, that they do not grip in the centre of the ship, that there is that narrow part. I imagine Major Palliser can tell us whether there is any way of obviating that, or whether it is a *bonâ fide* objection. That I think would also be interesting to us; and if he would be kind enough to say whether the system of stopping the breech of these guns is at all acted upon by the experiment which he began to show us.

Mr. BRAMWELL, C.E.: I do not know whether visitors at this Institution are allowed to speak. I have asked Major Palliser, and he tells me that they are.

The CHAIRMAN: Certainly.

Mr. BRAMWELL: The last speaker has put some questions about the relative cost of the projectiles made of chilled iron, and of those made of steel. I may say that I had occasion to enquire into the subject, and I discovered this very striking fact, that a steel shell involves, in the first instance, a solid forging which requires to be bored out in order to make the shell cavity. It then requires to be turned externally, and have other work done to it. The result is, that the cost of the steel which is bored out, and made into mere waste turning, is as nearly as possible the whole cost of a Palliser shell of the same size and weight. That fact, I think, puts the question of relative cost into a very simple form. As regards the operation of the bolts for fastening the armour-plates, I, as an engineer, was extremely interested in the results that was developed by the use of these bolts. We are aware that in machinery it is requisite to avoid all sudden changes of form; and Engineers who know their business, take care to specify that there shall not be any small collar, or other abrupt change of form in any piece of iron exposed to motion or vibration; because, if there be, it is a mere question of time as to fracture ensuing. Ensue it must, if there be an abrupt change of form. I have had very many marked cases come before me in my experience. One of the strongest, probably, was the case of a fly-wheel shaft, eighteen inches in diameter, which after working twelve years, broke from no other cause than from having a sudden projection upon it of half an inch on each side. That which has been known to Engineers as a base fact in the construction of shaft and similar machinery, Major Palliser has certainly applied in the most successful manner to these bolts. When you come to consider the reason of it, I think it is obvious; now that we have been told by Major Palliser how to do it, we may find out the theory. The theory of it, I presume, is this: that when the target is struck, there is a certain amount of momentum which has to be consumed in some way. It may be consumed in elongating a bolt which has two different sections, and where the change from the large to the small section may be very abrupt. The fact is when you pass from the small to the large (I can hardly explain it without a diagram, but I will not be at the pains of doing that) the small section, where it has to endeavour to stretch the large, has the whole force of the shot accumulating at that one point; whereas if you have the shank of the bolt equally small with the bottom, the thread of the bolt is equally capable of extension; and

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thereby, the extension of the bolt takes place equally throughout, and the momentum of the shot is consumed in that extension. In fact we saw that when the tripod was put on the table, the elasticity of the table did that which is done by the bolt itself. I think that is the theory of that which Major Palliser has so well brought before us. As regards the projectiles themselves, I was extremely interested with this: viz., that when those projectiles were fired, and broke up as they did in portions, although the points frequently passed through and were entirely uninjured, as they are now, if you picked up the portions that passed through, and laid your hand upon the fractured metal, not upon the outside which had been in the neighbourhood of the target, but on the interior portion, it was barely warm; but if you picked up pieces of a steel shell that had failed to pass through and had broken up, they would burn your hand. The conclusion is obvious, that in the chilled shell there has been no work consumed in altering the form of the shell; but the whole work has been consumed in destroying the target. In the steel shell, the form of the shell had been altered; you could detect it by the eye and by measurement, but even could you not have done so, the test of warmth told you that there had been a work done in the shell in changing its form, and therefore, the shell could not perform the work which it had to do, namely, to penetrate the target.

Captain R. A. E. Scott, R.N.: As nobody else seems inclined to rise, I wish to make a few remarks upon the subject. America is now building a large number of wooden corvettes. The vessels of this country will have to be prepared for all eventualities. I need not indicate the powers whom we are *not* to fear, but whom we are still to be prepared for. Now, it is at present in contemplation to lessen the heavy weighting of plated ships, and it has been more than once put forward, that vessels should carry half the amount of ammunition which is at present put on board, and that the remainder of the ammunition should be taken in transports, and supplied abroad. If that be done there will be a saving in weight; but it would still be of great consequence to have projectiles that will be good at all times. If you take a chilled shot, however good it may be against an armour-plated ship, especially when fired at right angles, that chilled shot will be of little or no use, comparatively, in firing through the side of an unarmoured vessel. What you want is steel shell of *large powder capacity*. These chilled projectiles have not that advantage. The chilled projectiles, thanks to Major Palliser and others who have devoted much attention to the subject, are good in attacking an iron-clad ship. But as I have said before in this hall, with respect to steel, you can temper it, so as to be tough. The thinner steel is, the better you can temper it. I believe, with the same amount of attention, and the same means of knowledge given to our steel manufacture, which Major Palliser has applied to chilled shot, that it would result in a cheap steel shell. I may mention that Mr. Whitworth is at the present time making steel shell which have been very *even* in their results, and are somewhat cheaply made; and much more still may be expected in that direction. To my own mind the experiments that have been made in firing angularly at plates (and we may be tolerably sure that that will be the general way in which we shall engage at sea we shall scarcely ever fire at right angles), have not been satisfactory. I see that they are manufacturing at Woolwich at the present time seven-inch chilled shot. I believe there are no chilled shell of seven inches being manufactured. I see that the chilled shell for the nine-inch gun which is being manufactured only holds 2 lbs. 13 oz. of powder. That is certainly, a very small amount, indeed. You want a very much larger amount; and it is steel alone that will not break up with the thinness of shell necessary to carry that large amount. There is another point:—The chilled shell require studs, or some other means of bearing them. The shell that were sent out to Halifax the other day were certainly not covered over, and the studs were smashed up. I know that they can be put in cases or boxes, but in time of war, when large numbers of shell are carried from one place to another, you will never be able to pack them in that way. That was one of the difficulties of the lead-coated shot before, and it is one of the difficulties that we shall get into with stud shot hereafter. I will now turn to the question of strengthening the cast-iron guns. What we want is not only a gun that will stand its charge on being fired, but a gun that will not break up when it is fired at. There is a very

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brittle metal outside, which is exceedingly thin. A strong metal is put inside; and as long as that metal is not extended, so as to rest against the cast iron, your gun is secure. But how do you know when it will not extend so as to bear against the outer cast-iron casing? I am not aware of any way in which you can test it. I believe if the firing were continuous that you would find your gun going; especially, if you left off firing in cold weather, and began again in warm weather. I believe the bursting of guns with the present large charges to be a very serious matter; it might result in the loss of an action. Certainly, we could not afford to take on board ship a gun that might burst when fired, or break up when struck by a hostile shot. There is another point I would mention. As far as we have experience at the present time of coiled tubes, it is exceedingly difficult to weld them together so as to make a complete joint. When fired with high charges, the coils separate. When that gun of Sir William Armstrong, the 300-pounder, which afterwards blew its breech out, was proved, the coils changed in the proof; at each round there was an alteration in the inner tube. We know that there is great difficulty in welding an iron tube so as to make it stand for the interior of a gun, and you cannot put cast-iron outside a steel tube. The only gun that was tried, that was made in that way, burst at the first round. I believe it to be essential for the endurance of our guns that we should have a steel tube inside and the strongest metal we can put on over it. I regard the efforts that are now made at the Gun Factory, at Woolwich, as most satisfactory; and I think great credit is due to the Superintendent and his manager, Mr. Fraser, for the system of manufacture they have introduced, which is undoubtedly at the present time the best known. I do not think I need go particularly into the fact as to the competitive guns. I can only say that I dissent in toto about No. 1, No. 2, and No. 3; I do not wish to go into that. But as to the gaining twist, there is a great mistake usually made. It is said that your shot should start easily, and should then be whirled up. It happens that when you push your shot home, if you have an even twist, that the stud or bearing, or whatever it may be, is resting against the loading edge; and when the powder is acting upon it, it has a little space to move in, whether it is the 800th part of an inch, or whatever it may be, before it touches the bearing side of the groove, and, all danger is over as soon as the shot has moved. Therefore, I do not see the value of that argument as to the gaining twist, and it seems that Major Palliser himself has very great doubts on the matter. I think that great variations have been made in this rifling. When Captain Haig, the Assistant Secretary of the Ordnance Select Committee, assisted Major Palliser in rifling his gun, the rifle twist commenced not where the shot lay, but it was at that point very nearly half the amount of twist at which the rifling terminated. I observe that the Ordnance Select Committee are gradually working back to the even twist, and I have not the slightest doubt they will end there. Despite what Major Palliser has done, and he has shown some admirable experiments this evening, and is entitled to very great credit (nobody who has taken these things in hand but knows what great thought and attention they require, and must give Major Palliser full credit for everything he has done in that respect), I say despite all this, I dissent with respect to strengthening the cast-iron guns; and I dissent also with respect to introducing a chilled projectile without a much fuller trial of steel, which I am sure is the material we shall ultimately come to, just as we shall come to an even twist in rifling.

Captain TYLER, When Major Palliser replies, I hope he will be good enough to tell us something more about the chief points of his projectiles; and whether he has fixed upon any particular shape as being the best. Captain Scott referred to that subject to some extent. And perhaps he (Major Palliser) would go on to say whether he has tried flat-headed shot. I observe that the shot in some of those diagrams have round heads, and not pointed heads, such as those which have gone through the armour-plate. It will be very interesting to know what, in the course of the experiments, are the exact results obtained from different shaped heads to the shot. As I have understood hitherto, these pointed shot will go through the armour-plates more easily when they are fired directly at them; whereas the square-headed or round-headed shot will penetrate more easily than pointed shot when they are fired at an angle towards them. With regard to the bolts that Major Palliser has shown us,

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the experiments were exceedingly interesting; and remind me, as they must have reminded Mr. Bramwell, who spoke so well on the subject, of the way in which axles have come to be made in railway engines and railway carriages. It was found when the axles were made with parallel sides that from the want of elasticity they broke rapidly and suddenly near the wheels; but by being made thinner and thinner in the middle, they at last arrived at a point when they were actually stronger than when they were thicker. Very much the same result occurs with these bolts of Major Palliser. By making them thinner at one part he really makes the whole bolt stronger than they would otherwise be. There was one point brought forward by Mr. Bramwell that I could not agree with; and that was with reference to the reason why these chilled shot penetrate so much better than the steel. Mr. Bramwell gave us a very lucid explanation upon that point, and told us how it was that the steel shot was much hotter than the chilled shot after it had struck the target; and he deduced from that fact that the steel shot had done its work in altering its own shape, while the chilled shot, as I understood him, had expended its work in penetrating the target. Now, I apprehend, that steel shot and chilled shot have both the same amount of work to do in penetrating a target. I did not quite understand how it could be, if there be an alteration of shape in the steel shot, why so much heat should be developed. I should like to know whether that has been satisfactorily ascertained from a great number of experiments, or whether there may have been some mistake about one accidental case. It is quite clear that steel shot may be made so very hard that almost no alteration of the shot would occur in striking a target, as is the case with chilled shot. Therefore, if we could get a little more information upon this subject, and perhaps Major Palliser will be able to give it to us, it would be very interesting.

Captain MOLONY, R.A., Asst. Sup. of Royal Gun Factories: There is one point on which I hope Major Palliser will offer some explanation: that is, how he proposes to give the necessary strength to his compound guns in the longitudinal direction. The effect of the longitudinal strain, he has clearly explained, is to blow the breech off. It is in this direction his guns have always shown great weakness; and it is in this direction that, even in guns altogether of wrought-iron, there is a tendency to weakness. Major Palliser—I do not know that he proposes putting steel into his guns—puts a wrought-iron coiled barrel into a cast-iron casing. Wrought-iron coiled barrels cannot be made with solid ends; consequently the whole longitudinal strain, coming on the inserted cup or plug at the end of the bore, is at present resisted by the cast-iron casing alone. I hope that he will clearly explain how he proposes to strengthen guns in that direction.

Dr. TYNDALL, F.R.S.: I am exceedingly reluctant to add to the weight already put upon the shoulders of Major Palliser by adding to the questions proposed to him. I would beg permission to express the great gratification with which I have heard this paper this evening. I think the spirit in which this investigation has been conducted is the true spirit. He has gone on making his footing sure, basing himself on the sure ground of experiment, as he went on, making experiments on a small scale before he attempted experiments on a larger scale. I must say that the course he has pursued is such as will be justified by the experience of every scientific man accustomed to experimental research. Now, I dare say there are many persons present who would very much like to know the precise process by which those wonderful bolts have attained their present tenacity and rigidity. We hear of chilled shot; and I am equally persuaded there are many present who would like to hear from Major Palliser's own lips how this process of chilling is conducted. With reference to the observations that fell from Mr. Bramwell, respecting the amount of heat developed, no doubt when a projectile strikes a target, the total amount of heat developed by the stoppage of a certain amount of motion, is always the same. If the Palliser projectile goes through the target, and if a steel projectile of the same weight and velocity stops short and does not go through, there is a greater amount of heat developed at the target in the case of the steel, than of the Palliser projectile; there is no doubt of that. It depends entirely upon the amount of *vis viva* annihilated. Then the question arises, how is the heat distributed? That depends upon the comparative rigidity of the target and the projectile. If the

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statements I have heard to-night are correct, the proportion of the total heat which comes to the share of the projectile is greater in the case of the steel projectile than in the case of the chilled shot. That would prove that the density and rigidity of the chilled projectile is of such a character as to throw the heat more upon the target than upon the projectile. I say that, as far as this goes, it is in favour of the chilled projectile.

Mr. BRAMWELL: I may say, for the information of the gentleman who asked that last question, in whose views I very much coincide, that I said studiously, if you put your hand upon the interior of the broken-up shot, the interior of the Palliser shot or shell had no heat that was at all harmful to the hand, while the steel shot or shell, owing to the change of shape that had taken place had the heat developed in its interior. Of course, with regard to the exterior of the shot, whether it were chilled shot or steel, its heat would be due to contact with the target.

Mr. MALLET, C.E., F.R.S.: I think there has been a little misconception as to the importance of this question of heat. I happened to have been present myself on the 24th of October last, when the experiments were made to which Mr. Bramwell has alluded, when steel shell was fired along with a number of chilled shot and shell. I felt the fragments of both of them in my own hand. Those of the steel shell were undoubtedly colder—the portions that I took—than those of the chilled shot. But I attribute no importance to that one way or the other. If you attempt to estimate the relative values, the practical values of projectiles by refinements derived from questions of the amount of heat developed, you will go far astray. It is simply preposterous to talk of there being any superiority in the properties of chilled shot over those of steel projectiles on such grounds. It is a question of comparative price and practical utility, of convenience rather, in use as an artillery instrument. If you can make to the end of the chapter chilled shot cheaper than you can make steel, then I say by all means adopt them. My belief is, knowing something practically of the question in other directions, that the time will come, and is not very distant, when cast-steel shot or shell will be made quite as cheap as chilled ones. Steel shell are being made now quite as cheap, as far as my information as to their cost at Woolwich goes, as chilled shell, and they will be found, I believe, decidedly superior. We know pretty well what the co-efficient of cohesion is, and what the co-efficient of rigidity is in both. Now chilled cast-iron, means iron that is soft in the interior and hard on the outside. These shot which were tried on the 24th of October and produced such remarkable effects, and which I entertain a very high opinion of, were not in the proper acceptation of the word chilled shot. They were simply white cast-iron shot, and would have been much the same had they been cast in sand. If you can at the same price make cast-steel shot or shell, you will have a better projectile than any projectile you can make of chilled iron or cast white iron. There have been so many points brought forward to-night that it would be quite out of the question to attempt to refer to them in an orderly manner. But there is one point more which I think Captain Tyler alluded to, that I would remark upon; namely, as to the advantage obtained by the use of pointed projectiles compared with flat-headed projectiles. I was, myself, in company with Mr. Whitworth and several other persons, originally an advocate for flat-headed projectiles. I gave in evidence before the Iron-plate Committee my opinion as to what sort of flat-headed shot would be most likely to penetrate armour-plate. I believe I was entirely wrong. The first man, I believe the first man in Europe, who on *à priori* principles showed that that view was wrong was no one in this country, but Professor Haughton, Fellow of Trinity College, University of Dublin, who in a paper published in the proceedings of the Royal Irish Academy, and as resulting from investigations made by him, predicted the fact that a shot having a conical point, or with an average angle of about 70 degrees, which is what has actually been come to at Woolwich, would, on principles that he had already applied to a totally different subject, viz., physical geology, be that which must necessarily penetrate armour-plate with the smallest expense of force. I believe that great merit is due to Major Palliser for having persistently hammered into the ears of the authorities that the hardest and densest and toughest material was that which would be the best for penetrating armour plate.

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Dr. TYNDALL: Will you allow me to say one word with regard to the development of heat. Mr. Bramwell has said something about the contact. The heat as developed is entirely measured by the amount of motion stopped. If you take the velocity of the projectile just before it strikes the target, and, supposing it to pass through the target, if you take its velocity immediately after it has passed through, the difference between those two velocities is the measure of the heat produced. It may be a minute, or a second, or part of a second, it is entirely independent of time; it depends upon the amount of motion stopped in passing through the target.

Mr. MALLET: In every case it is divided between the distortion of the shot and the distortion of the target.

The CHAIRMAN: If no other gentleman has any remarks to make, I will now call upon Major Palliser to reply.

Captain TYLER: Just allow me to say, that Dr. Tyndall has given us the proper theory as to the amount of heat that was developed in the case of shot passing through the target. Would he go on to state what occurs when the shot hits the target, and fails to pass through? In that case, the whole momentum of the shot must be turned into heat.

Major PALLISER: Captain Harrison asked me first as to the relative cost of the conversion of existing guns, and of the construction of a new gun of wrought iron. It is impossible for me to say what the relative cost would be, as I have been unable to ascertain the cost of a cast-iron gun converted, or what is the actual cost of a gun made entirely of wrought iron. But this much I will say, that in that 12½-ton gun of mine, there was an interior barrel of wrought iron which weighed 2½ tons, and that the expense of that barrel could not be more than the expense of the same amount of wrought iron in a wrought-iron gun. There remain, however, ten tons of metal—of cast iron which were run round the barrel in about one minute and a half; and I leave it to anybody to form their opinion as to the relative expense of casting a mass of cast iron like that in a couple of minutes—when we have the cast-iron already in our possession not costing us anything—and the cost of making, turning and boring rings, shrinking them one over the other, and thus gradually building up a wrought-iron gun. With regard to the relative cost of the projectiles, I think Mr. Bramwell has answered that. I believe the cost of chilled shot is very little more than the cost of what they call common shell—the ordinary cast-iron shell filled with powder. The fact is that the chilled shot are so cheap, that I believe they are going to use them in practice.*

Mr. MALLET: Can Major Palliser tell us what is the actual cost in pounds sterling per ton for manufacturing, at Woolwich, the so-called chilled shell and shot?

Major PALLISER: I am not able to tell you that now; but I know that when they were first commenced, it was about £18 per ton. But we have got it lower than that now. One great advantage of the chilling process is, we find—at all events we feel pretty sure—that we shall be able to utilize the existing stock of cast-iron shot and shell in the manufacture of chilled shot, and then they will be very much cheaper. But Mr. Mallett has said that casting white-iron shot in sand is not different from casting one of these chilled shot. Now, I beg to say, that the first person who analysed a specimen of chilled shot was Professor Abel, the chemist of the War Department, in 1865. I asked him to analyse some portions of the chilled shot, and he did so, and he found they differed in no way in their component parts from ordinary white cast iron. Then, it occurred to me, if that is the case, there might be no objection to cast white-iron shot in sand. But it was found that the grain of such shot was very open. If that chilled shot were split open, the grain would present a most extraordinary appearance, and it is this intense hardness and closeness of grain which contributes much towards the superiority of the chilled shot.† This closeness of grain is caused by the violent contractions of the

* This question has since been decided in favor of using common shells in ordinary practice.—[ED.]

† NOTE.—Subsequently communicated by Major Palliser. "A 7-inch, white iron shot, cast in sand, weighing 123½ lbs., has been lately fired at the "Warrior" target with a 15 lb. charge, and failed to penetrate it, while a chilled shot of 114 lbs.

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exterior portions of the projectile which become suddenly solidified and compress the interior while still in a liquid state. In addition, the chilling process enables you to utilise a great quantity of iron which you otherwise could not. Further, the iron employed is made so intensely hard, that it cannot be turned; and you can cast the iron in an iron mould more accurately than you can cast it in sand, unless you go to the expense of dry loam moulding which is more expensive. Another advantage of the iron mould is the facility it affords for casting the stud holes in the shot. Altogether, the advantages conferred by the chilling process render it far superior to casting shot possessing similar properties in sand. In 1864* I pointed out that the whole discovery in these shot consisted in finding out that that *toughness*, on which Mr. Mallett has laid so great stress, was of no importance; and that all that was required was great hardness—or rather resistance to compression—combined with a form of head which would apply the pressure *gradually* to the shot. I believe that a blow is nothing more nor less than a severe pressure applied for a short time; that to flat-headed shot this pressure is *suddenly* applied, whereas to the conical or ogival-headed shot this pressure is *gradually* applied. If you refer to the Report of the Iron-plate Committee in 1865, and that of the Armstrong and Whitworth Committee, you will find they call attention to the great tendency of steel shot to break up on impact, and to the great care with which it was necessary to temper these shot. In fact, the Committee looked upon toughness as one of the most important elements in the shot. Captain Scott said that these shells had small capacity. I beg to say that shells of large capacity have just as good penetration as shells of small capacity at the direct target. At the inclined target they have not. At the inclined target the solid shot has better penetration than either kind of shell. But as far as firing at a direct target, or anything moderately direct, the shell of large capacity has a penetration equal to either the shell of small capacity or the solid shot. With regard to flat-headed steel shot, one of 250 lbs. was fired from a 9-inch rifled gun with 43 lbs. of powder at 200 yards distance at the 8-inch plated "Warrior" target; it made an indent 4½ inches deep and rebounded from the plate; while a chilled shell of the same weight fired the same day from the same gun with the same charge, went right through the target and burst on the other side. I do not think it is necessary to say much about the liability of converted cast-iron guns to break up under continuous firing, when the first rifled lined gun I made was a 68-pounder converted into a 7-inch rifled gun and it fired 800 rounds without bursting. With regard to the uniform spiral and the increasing spiral, the very fact that Captain Scott has mentioned, that the shot at first hugs the loading edge of the groove and leaves a space of say the 800th part of an inch between the

weight, fired at a similar portion of the target, on the same day, with the same charge, and from the same gun, penetrated the target completely and tore away some supporting beams in rear."—[ED.]

* *Vide* the following extract from Major Palliser's letter to *Mechanics' Magazine* of 22nd July, 1864:—

"At the time I first heard of Mr. Whitworth's tempered steel shot, I conjectured that the results he obtained were to be attributed as much to the hardness as to the toughness and tenacity of the material he employed. I had previously noticed in some experiments that I had made in casting iron round wrought-iron tubes, that, under certain conditions, the cast-iron was rendered very hard and unyielding where it came into contact with the cold wrought iron. I was aware that cast-iron would resist a far greater crushing force than wrought iron could, and putting these facts together, I thought it highly probable that if I cast an iron shot in a mould that would rapidly carry off the heat by conduction, and if at the same time I made the fore part of the shot of such a form as would convert the sudden shock of impact as much as possible into a uniformly increasing pressure, the brittle nature of the material would not be of much consequence. I accordingly made a model iron-plated target, a small rifled cannon, and cast some shot to prove the truth of my conjecture. At the time I commenced the experiment, I had never heard the expression "casting in chill." As soon as I had satisfied myself by experiment that the theory held good on a small scale, I sent the gun, target, and shot, last May twelve months, to the Ordnance Select Committee."—[ED.]

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surface of the stud and the driving edge of the groove, shows that when t
starts, it does not at once come in contact with the grooves. Therefore, th
move through a certain space before it meets with the sudden resistanc
clined groove; and the amount of that sudden resistance would be meas
initial angle of the rifling. What I mean is this: if that were a rifled g
this the flange on the shot (pointing out the different parts), as Captain S
hugs the loading edge. When fired, he says it does not immediatel
driving edge. This is quite true. But what is the result. That fla
tendency is to go straight on in that direction, suddenly comes
with this uniform spiral groove, when the shot has not only receive
shock of the powder, but when a considerable amount of velocity ha
accumulated in it. The stud, or flange, therefore, strikes a violent b
the groove. This is a matter of little importance with small guns; b
come to use large projectiles fired with high velocities, you must have a
spiral groove. Why I lay particular stress upon this is, that I am an advo
coiled barrel, despite what anybody says. I say that the grooves in thi
rial will not stand the shock of such a heavy body coming suddenly upo
you must have an uniform spiral, you must also have a great number of g
a great number of studs for each groove, in order to distribute the pre
large bearing surface. If you want a large gun to fire heavy shot with
number of studs on them, you must have the increasing spiral groove, a
objection to it whatever. With regard to the particular form of the
shell, it is what is called an ogival head, and is formed by the intersec
arcs of a circle whose radius equals 1½ diameters of the body of the shell.
of head so far as our experience has gone, has penetrated better than an
With regard to solid shot, the Ordnance Select Committee have sacrifi
amount of effective power in order to get a longer body and therefore be
in the gun, which gives increased accuracy of shooting. They have hith
the head with a radius equal one diameter, but I believe in future th
one and a quarter diameter. With regard to the seven-inch shells, I
reason seven-inch *shot* have been ordered was that the authorities were
obtain at once something which they had found to be good, to adopt it
to trust to experiments for further improvements. Next year, howev
have 7-inch shells.

The CHAIRMAN: A gentleman has asked how the shot are made?

Major PALLISER: The shot are made in this way. There is an iron m
is in the form of the shot, and there are holes made in it in which san
put; the metal is simply poured down through a hole in a sand top or co
sand studs in the mould, cast the holes in the shot to receive the gun
and the shot comes out practically finished, with the exception of puttir
in and cleaning off any roughness, and painting.

The CHAIRMAN: Will you be kind enough to complete the explana
cascable of the gun?

Major PALLISER: If you notice, the breech of a gun is the converse o
bolt. A female thread is cut out of the body of the gun, which
the converse of the male thread cut on the screw bolt. Hence, the su
which comes here (pointing to the screw thread in the breech of the g
tendency to the gun to break here (see Fig. 8, Plate viii). And a gun
break off its breech at that place. This fact has been harped upon a grea
I think it only fair to state that the powder employed was of an excessi
and violent character, and such powder has never been used since. It
called No. 2 A 4 powder; further the charge was fired at two places at
is to say, there was a vent towards the rear end of the charge, and a v
the front, and the large powder charge was fired simultaneously at both
electricity.

The CHAIRMAN: I feel confident that I am expressing the wish of the
returning to Major Palliser our warmest thanks for the very interesting
he has read to us. I have no doubt you were all remarkably struc
successful progress of his experiments, as one after the other, they have

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tion led to their present completeness. The success which has attended the progress of his experiments, is very remarkable as regards the facts connected with his projectiles. And although it may be that for wooden vessels chilled shot is not the particular missile most suited for offensive use, that is not the question which has been under consideration. It is the piercing of armour-plated vessels; and in attempting that, Major Palliser's success appears to have been complete. Many gentlemen have brought their great talents to bear on the subject of artillery, and have given the benefit of their knowledge to improve the offensive and defensive means of our country. Most of them have reaped but a barren reward for the practical issue of their experiments. I trust Major Palliser not only will rejoice in the knowledge, and feel satisfied with the reflection of having done so much, practically, for the good of his country, but that he may also reap what is more unusual, an adequate substantial reward, in the shape of a pecuniary grant from Government.

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Evening Meeting.

Monday, April 8th, 1867.

General Sir WILLIAM J. CODRINGTON, G.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 1st and 8th of April.

Freeth, Walter, Esq., Commander-in-Chief's Office. 1*l.*
Busk, Hans, Captain, 1st Middlesex Victoria Rifle Volunteers.
Lamprey, Jones, M.B., Surgeon 67th Regt. 1*l.*

MILITARY BREECH-LOADING SMALL ARMS.

By Captain V. D. MAJENDIE, R.A., Assistant Superintendent, Royal Laboratory, Woolwich.

THE present time would seem peculiarly favourable for the consideration of the subject which is set down for discussion this evening. Not only has public attention been recently forcibly drawn in this direction, but we stand at this moment in a position which gives to the subject, as far as this country, at least, is concerned, a peculiar completeness.

Considered broadly, the subject falls naturally into three main subdivisions—the past, the present, and the future of breech-loading arms. The ancient history of breech-loaders has already been dealt with in this room; most of you know with how much ability and care. The future of breech-loaders is a question of much speculative interest, and one which branches off into several lines of curious enquiry. It is one, too, of high importance, in its connection especially with the probable influence of the new arms upon military movements and organization, and upon the relative probable value of infantry, cavalry, and artillery. But this evening my remarks will be limited as closely as possible to the middle phase—the *present* of breech-loading; nor shall I go further back or further forward than may be necessary to ensure connection and completeness.

The advantages which breech-loading presents over muzzle-loading for military small arms are, as we shall presently see, so great that its employment amounts to nothing short of an instinct. So much more natural is it to introduce the charge of a gun at the breech than at the

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muzzle, that a very large proportion of the early hand guns were so loaded. The system, no doubt, was abandoned mainly on account of the greater perfection in mechanical workmanship required in breech-loading arms—a perfection scarcely attainable in those early days, but which the gradual development of the force of gunpowder rendered more and more indispensable. The development of the system was hampered also by other considerations which will be more apparent as we proceed, but which sufficed to neutralize in a great measure the advantages which we should otherwise have derived from its adoption.

Looking at the subject from the ground which we now occupy, it may justly create surprise that, with one important exception, every military power in Europe has been content hitherto to rely upon a muzzle-loading musket for the general equipment of its troops. In truth, however, the subject had never, until lately, been fairly faced and considered. It had been viewed in a half-light, experimented upon from time to time with languid interest, cramped within contracted limits, misunderstood, suspected. When the instinct of which I have spoken had been blunted by a different habit, men had not set themselves diligently to reckon up the abstract advantages of a breech-loading military arm. It was a thing of the past—or it might be even a thing of the future, but never a tangible reality of the present. One reason of this indifference is to be found in the fact that each nation considered itself with its muzzle-loading rifles at least as well off as its neighbours, or so far in advance of them even, as might be measured by the superior accuracy and perfection of its arms. These muzzle-loaders, too, had won for us some scores of great battles, and had served as efficient tools wherewith the greatest commanders in the world had worked their way to fame. Finally, their supersession would entail an expense and an amount of anxiety, and possibly of difficulties, which there seemed no sufficient reason for incurring.

It must be remembered that the change involved in the supersession of a particular class of military arm is a very serious one to make: serious, because of the interests and issues involved; especially serious in our case, because of the scattered nature of our forces, and the variety of climates and conditions to which our equipment must be suited. What country, except England, has to provide ammunition, for example, which neither the intense cold of a Canadian winter, or the heat of an Indian summer, or the searching damp of the Indian rains can injure or affect; which under these opposite influences will still give the same sort of results with which the annual performances at Wimbledon have familiarized us, and which the fastidious criticism of a free competition and a free press have taught us to require? Inertia has to be overcome by all new ideas and inventions, as by all material things, before they can pass from that state of rest in which sometimes to our loss, no doubt, but not seldom to our benefit, so many of them eternally remain. I do not know that the military profession is specially open to reproach because it does not admit an opposite law. When occasion demands the required force is generally forthcoming. It may be the force of public opinion; it may be the

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force of science; it may be the force of progress and force of intrinsic merit; and it is undoubtedly better in the country and ourselves, that we should yield only to t be sensitive to the mere touch of every ingenious invent weak, restless craving for change and ideal perfection w be confounded with real progress.

Those who believe that breech-loading rifles formed r equipment of the British army until the present or the pa they sprang directly out of the performances of the needle-g Bohemian campaign, will learn with surprise that not onl loading been determined upon for our infantry nearly thr and the actual pattern of arm that is now in the hands of portion of our troops, decided upon a full month before K fought, but that two regiments of English cavalry were pr breech-loading carbine ten years ago. If we examine Sharp's carbines, as they are called (Plate x, fig. 1), we n an objectionable feature, viz., that the ignition is effected l percussion cap. Then, again, the arm is provided wit arrangement for checking the escape of gas. So great is that a handkerchief laid over the breech at the moment c be burnt through and through; whereas with a close-fi cartridge, the handkerchief should not be even soiled by th here for example is a piece of calico which has been laid up of a Snider rifle for 40 rounds. This defect is aggrav quantity of powder, which in damp weather adheres outsi after loading. The back end of the cartridge is cut off t powder sprinkled about. From these two causes, the f generally flecked and burnt in firing; while the escape also to foul and clog the breech action, which exposes surfaces, and to render the arm more difficult to open as c fired. For these reasons, the retention of the percussi liability to an escape of gas; the flash occasioned also powder; and the difficulties which often arise in loading, th extremely imperfect. And yet this system did undoubte some extent the state of feeling which prevailed in thi the subject of military breech-loading arms a few years a that time this question was regarded exclusively as a caval and quick shooting was scarcely thought desirable fo soldier. It was desirable no doubt that he should be rel inconveniences which attend muzzle-loading on horse veniences so great as to be almost ludicrous, when we thi under fire trying, on the back of his horse half-maddened by n ment, and terror, to pour gunpowder down a narrow tube, t a bullet, and to adjust a percussion cap on the nipple of hi the cavalry soldier has hitherto been required to be essentiall man, not a trigger-puller; and so much emphasis was laid upon this consideration as to engender, what I cannot as a very dangerous undercurrent of opinion, that the effici hussar or the dragoon would be best assured, by providin a sharp sword and a not too effective fire-arm.

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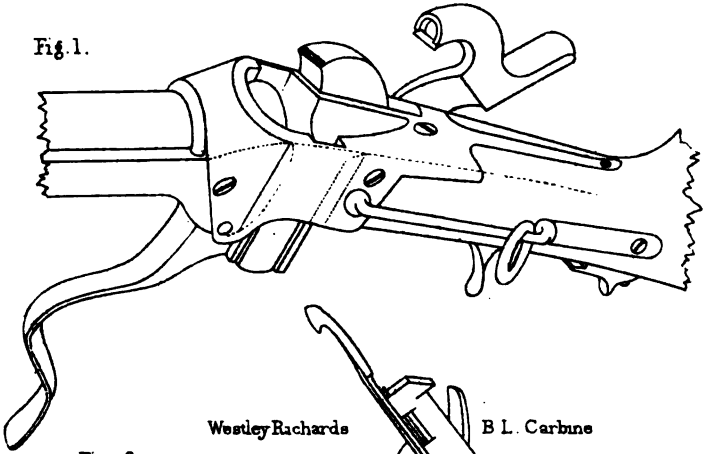
Sharp's Breech loading Carbine

Fig. 1.



Westley Richards B L. Carbine

Fig. 2.

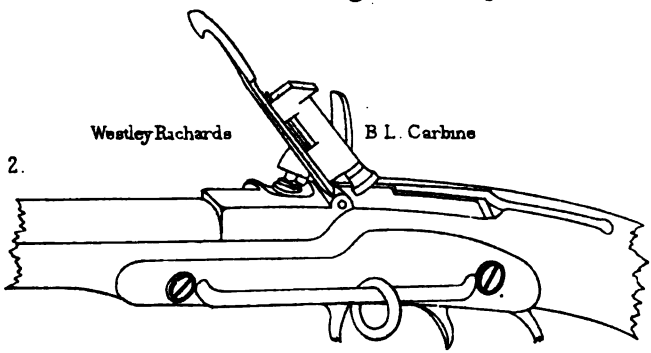
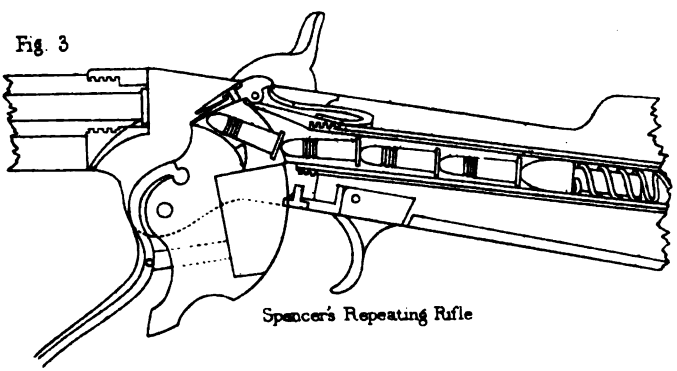


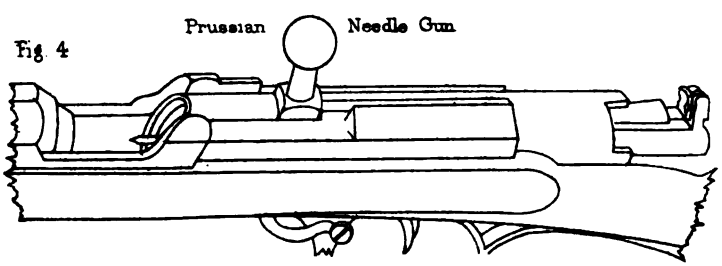
Fig. 3



Spencer's Repeating Rifle

Prussian Needle Gun

Fig. 4



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Between 1857 and 1861 three other breech-loaders were introduced for experimental cavalry use. One of these, the Green's carbine, even in that easy age, never obtained a footing as a recognized service arm. But the Terry carbine, which I have here, was introduced to some extent, and is not yet entirely obsolete; and the Westley Richards' carbine (Plate x, fig. 2) has found justly more favour. In 1861 this arm was definitively adopted. It is a great improvement on the others which I have named. It is an accurate arm; it fires six or seven rounds a minute with comparative ease and certainty; it spills no powder; it does not burn the firer's face or facings. Until the recent competition, Westley Richards' was accepted as the best type of military breech-loading arm known in this country, and, with its many objections, I would still pronounce it one of the most effective capping breech-loaders which has been produced.

But we have now to consider the subject in a broader light. It had been treated hitherto from one narrow point of view—as almost exclusively a cavalry question. We had considered only arms of which the percussion cap formed a material element, and a capping arm may be pronounced, with our present knowledge and for our present purpose, only half a breech-loader. Thus far, then, we may justly say that breech-loading had been cramped within contracted limits, and had been misunderstood. But a couple of years or so ago, the whole aspect of the case altered. As by a revelation we learnt then, what breech-loading really meant, and of what development the system was capable. It was a great epoch for breech-loading, its Hegira, it might be called, when it was discovered that the objections to cartridges containing within themselves the means of ignition, had in reality no force. If we are to trace the stagnation which had hung over the question, to a definite cause, we may confidently place our finger upon these objections.

When men said, and the ablest and most experienced military men did say, and our military authorities laid it down as a fundamental axiom, that cartridges containing their own ignition were not admissible for military use, what they meant was: 1st, That such cartridges were more liable than others to accidental explosion; and 2nd, That in the event of the explosion of one cartridge, the contents of the barrel were liable to be all exploded *en masse*, and so to communicate from barrel to barrel. If we grant these premises, the conclusion is just. Ammunition which is liable to explode in bulk, and thus not only to commit injury and dangerous havoc for the moment, but by its explosion to deprive the troops dependent upon it of their supplies, is clearly not admissible for military use. But when, mainly, I believe, by reason of the explosion of gunpowder at Erith two years and a half ago, men's minds were directed towards explosions generally, an experiment was made to determine the liability of small-arm cartridges —not breech-loading cartridges in this case, but the ordinary muzzle-loading Enfield rifle cartridge, ball and blank—to explode in bulk, and it was established not only that the explosion of a single cartridge in a barrel was not communicated to the rest, but that the explosion of a number of cartridges, or even of ¼ lb. of loose powder, although it might burst open and destroy the barrel, would not occasion

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a general explosion. Although the bearing of this fact upon the question of breech-loading was not immediately perceived, it furnished the opening through which presently a flood of strong new light rushed in upon the subject.

This effect proceeds from the same cause as that which operates in rendering the well-known Gale gunpowder inexplosive. Mr. Gale enclosed each grain of his powder in an incombustible envelope of finely-powdered glass or bone-dust. You know, doubtless, the result. Here is some powder rendered non-explosive by the introduction of four parts of powdered glass. I stir the mixture with a red-hot rod, and as you see without exploding it. If I separate the powder from the diluent, we at once, as you see, restore its explosive character. Now in a barrel of cartridges we have not each grain enveloped, but a number of grains, so many as compose one charge, in a non-combustible case. I have tried over and over again to explode a barrel of the service breech-loading cartridges without success. I have several times fired one cartridge in a barrel without igniting the remainder. I have fired ten cartridges at once, and no more have exploded. I have gone further, and placed the barrel inside this iron cylinder, tightly screwed down, and have exploded ¼ lb. of powder in the midst of the 700 cartridges which it contained; and although the screws were broken and the lid of the cylinder was blown off with violence, and some of the cartridges were strangely distorted, none of the cartridges were ignited. Experiments not less exhaustive have established also the non-liability of these cartridges to separate accidental ignition by concussion or otherwise. In this way we dispose of the objections which have been entertained against cartridges containing their own ignition, and establish their admissibility for military service.

Although between 1859 and 1864 no less than 26 different plans of breech-loading were proposed; although for sporting purposes breech-loading guns had found their way into very general use; and although in America they were being largely applied experimentally for military use, this shadow always hung over the question—that cartridges containing their own ignition were not generally considered admissible for military use. And as breech-loaders not adapted for such ammunition presented comparatively few advantages except for cavalry, for whom as I have explained, quick firing was not specially desired, and as the development of the system was thus stunted, the question was in fact argued in a circle, and the subject remained up to this period practically at a stand-still.

But when this fatal restriction and limitation were removed—we began at once to make real progress in the matter. It was no longer a question merely of an arm which presented certain minor facilities of manipulation—of an arm somewhat handier to load on horseback—but it became obviously a question of an arm, which would multiply the fire of an army three or fourfold—which, properly considered, would place as it were three or four rifles in each soldier's hands.

In the course of the Dano-German war the value of the famous needle-gun (Plate x, fig. 4), or rather of the system of which the needle-gun was an indifferent exponent, became in the eyes of observant men fully

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established. So obvious was the teaching of this campaign, that the then Secretary of State for War, Lord de Grey, forthwith appointed a committee, with General Russell as president, to "report upon the advisability of arming the infantry, either in whole or in part, with breech-loaders." After four meetings this committee reported, abstractedly and without reference to any particular system, that it would be desirable to arm the whole of the infantry with breech-loading rifles; and on the day on which this report was drawn up, the 11th July, 1864, the death-warrant of muzzle-loading rifles for the use of the British soldiers may be regarded as having been signed.

The next question to be considered, was, how to give effect to the recommendation of the committee. This question admitted of consideration in two ways: either by itself with a view to ascertain the speediest and cheapest mode of placing a breech-loader in the hands of the troops, or in combination with other questions connected with rifles, such as the best size of the bore and the best mode of igniting the cartridge, and with a view to determine what would be, in all respects, the most perfect arm for the use of the infantry. The first mode of dealing with the question would have the advantage of celerity, the second of completeness. But why not have combined the two, by arming the British army immediately with the needle-gun? Here was a complete system—a good system, perhaps, some will say, ready-made to our hand; a system too which had had the advantage of having been tried on actual service, and which was certainly inexpensive. I have here a needle-gun which will I think answer this question for itself. Take the gun as it stands, and tell me—those of you at least, and I doubt not there are many, who are accustomed to handle the beautiful weapons which England puts into the hands of her soldiers, her volunteers, and her sportsmen—tell me if this clumsy rifle is one which you would have cared to see issued to our troops.

But why not, you will say, improve the workmanship of the piece—make it lighter, balance it better, alter its bore if need be, or its mode of rifling, improve its mechanism, and when you have suited it to the more advanced requirements of this country, adopt it? Need I point out to you that such a measure would have disposed of the first argument for the adoption of the arm. We are no longer in this case adopting a system ready made to our hands. We are in fact creating one. We are adopting a breech mechanism, merely one element of a system, nothing more. And but little knowledge of the subject was needed to instruct us as to the extremely defective nature or principle of this breech mechanism. If I handle the needle-gun you will see that its action is comparatively slow. It is clumsy and imperfect, in other ways. The needle with which the cartridge is ignited is very liable to become bent or injured. I shall be reminded that these needles are easily replaced, that each Prussian soldier carries two or three. But this injury and replacing of a needle, temporarily disables the arm, and constitutes, it must be admitted, an objection. Then again, the gas-check is not permanently reliable. The whole escape is thrown upon the arm, at the junction of the breech, none upon the cartridge; and even if we set out with a tight fit, the fit will become less and less

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close, and in time, if the arm be not carefully looked to and repaired, an inconvenient escape of gas will occur,—an escape which sometimes induces the Prussian soldier to deliver his fire by preference from the hip. Of the ammunition it will be sufficient to say that it is rude, and for technical reasons ill adapted for the requirements of military service. The egg-shaped bullet is embedded in a small papier-maché wad, which serves the double purpose of giving rotation to the bullet, which never touches the grooves, and of containing the fulminate, which the needle, penetrating the powder and the thin paper envelope which encloses the whole, has to pierce. In short the needle-gun, however superior even to a *good* muzzle-loader, was not such an arm as we should have been justified in adopting, except on an emergency more pressing than that which now presented himself.

Of the other systems of which we had any experience, and which you have seen, there was none which seemed calculated to satisfy our requirements, and their adoption was accordingly not entertained.

Under these circumstances, having no complete system to begin upon, we determined to take so much of a known and reliable system as we approved, and apply it. By this course we should get, as it were, a lift upon our road, and start somewhat in advance of the point from which we must set out, if we elected to consider the question *ab ovo*. Therefore, and without prejudicing the ultimate and more leisurely investigation which the question as a whole demanded, we resolved to take so much of the existing arm—the Enfield rifle—as seemed to us good, and to revolutionize that part of it which we deemed bad. We determined, in short, to convert our Enfield rifles into breech-loaders. In speaking of the Enfield rifle as a good arm, I am anxious not to be misunderstood. It is an arm doubtless with many defects, if we may judge it by the high standard of more modern requirements. A steel barrel, for example, would probably be preferable to a wrought-iron barrel; the Enfield twist is undoubtedly too slow for extreme accuracy; and the calibre may be considered as unnecessarily large. The refinements and progress of gunmaking have left the Enfield rifle to a certain extent behindhand, just as the refinements and progress of breech-loaders have left the needle-gun behind; and yet in the main it is an excellent weapon for military use, and I know no power whose soldiers possess a muzzle-loading rifle which can compare with it. We do not, recollect, require a match-rifle for military purposes. Except, on a few rare occasions, such an arm would have no special value. It was Lord Palmerston, I think, who pointed out that what the soldier is required to do is, not to hit a particular button upon his enemy's coat but generally to drive home an effective fire into an opposing body of infantry or cavalry.

Extreme accuracy is of course a good thing to have in a military rifle, just as well as to have a watch which will beat time like a chronometer; but for the ordinary circumstances of warfare, a rifle of average precision, say of the precision of the Enfield rifle, will answer all our purposes, just as a chronometer movement is not absolutely essential in every-day life. If we can get the extreme accuracy in either case, without sacrificing other qualities or without great outlay, well and good—but men exposed to a searching fire, hurried, wearied,

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confused, surrounded by smoke and strange noises, wounds and terror, will fail generally in giving full effect to the precision of which even a moderately accurate arm is capable.

Instructed then by the sober teaching of actual warfare, we were justified, I think, in assuming, that if to this Enfield rifle, without subtracting from its accuracy and other qualities, we could apply an effective breech-loading arrangement, we should be at once relieved of all pressing anxiety, and in a position to select leisurely a new and superior weapon for future manufacture. Moreover, there were more than half-a-million of these muskets available for conversion; and the step which was proposed had the secondary, but by no means inconsiderable advantage of economy. It had other subordinate advantages, such as the experience in breech-loading equipment to be derived in the course of the enquiry, and which might stand us in good stead when the more complete and difficult question should come before us, and finally, the avoidance of the danger of hurrying without due consideration, into the adoption of a possibly unsatisfactory arm.

In August, 1864, an advertisement was issued, inviting gunmakers and others to submit propositions for the conversion of the Enfield rifle. From the fifty systems which were sent in in reply to this advertisement, those which were obviously unsuitable were eliminated, and eight systems were selected for trial, of which five only, for reasons which it is unnecessary for me to detail, ultimately came to the post. Of these, four were capping arms, one only a non-capping arm. The selection for trial of these capping arms, indicates that we were not then as advanced or decided upon this point as we are now, and had not yet absolutely learned to regard non-capping as a *sine qua non*. So Westley Richards', Mont Storm's, Wilson's, and Green's converted Enfield rifles entered the lists against the solitary representative of the non-capping system—the Snider rifle.

Westley Richards' converted Enfield, was substantially the same in respect to its breech mechanism as the cavalry carbine which I have shown you, with the addition of a small hook at the end of the plunger for withdrawing the wad after firing.

In Wilson's arm, the breech of the original rifle is removed, and the barrel prolonged for some inches in the form of an open slot. The cartridge is inserted here, and pushed forward into the barrel, and is followed by a sliding plunger, which is fixed after loading by a stout bolt which passes through stock and plunger. There is an india-rubber ring to diminish the escape of gas.

The Green rifle resembled the Wilson, except in the manner of securing the plunger, which is furnished with a small knob, and is turned round after loading, a quarter circle, and so locked.

The Montgomery Storm, or Mont-Storm arm is one of that class of breech-loaders known as "chamber-loaders," and of which I shall have to speak again presently. The chamber of the Storm rifle can be turned completely over the breech, and loaded; or it may be swivelled at right angles to the barrel for loading with loose powder. When the chamber is returned, it is secured by a bolt worked by the lock, and escape is prevented by an expanding ring or thimble on the pan of the chamber.

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In the first arms made on the Snider system, about two inches of the upper side of the breech end of the barrel were cut away, leaving a wide open slot or trench for the admission of the cartridge. When the cartridge had been pushed forward into a taper chamber formed by enlarging what was now the hind part of the barrel, the slot was closed by a lump of steel, hinged on the right side of the barrel and forming a false breech. It was afterwards found more convenient to remove the back part of the barrel bodily, and to replace it with a "shoe," in which the whole of the breech arrangement was comprised; other modifications followed, until we got at last, the more perfect arm which I hold in my hand (Plate xi). The breech-block, you will see, hinges upon this side pin and works backwards and forwards. It is kept in its place by a small spring stud; and the fit of the block tends also to hold it.

In order practically to meet a possible objection that this arrangement is liable to wear and get out of order, I have brought to-night for your inspection, two Snider rifles. One of these rifles has fired, under my superintendence, 15,082 rounds; the other has fired 17,082 rounds; or if you would go further still, I have here a "shoe" which has never even been hardened, and yet which has fired 30,000 rounds and still remains, as you will see, if you care to inspect it presently, perfectly serviceable. Nor have these rifles and this "shoe" been tinkered up for exhibition. On no occasion have they become injured or even temporarily unserviceable—and although springs and pistons do sometimes break, I can only say that these springs and pistons throughout all this practice, have not once required renewal or repair.

The ignition is effected by means of a small piston or striker, which passes through the breech-block, and which, when in repose, is flush with the face of the block. A blow of the hammer causes it to dart forward about a tenth of an inch into the cap, which is fixed, as I shall presently more particularly explain, in the base of the cartridge. The piston is returned by a spiral spring. To withdraw the empty cartridge case, a claw or extractor forms part of the breech-block. When I withdraw the block, the empty cartridge is necessarily drawn with it, and by canting the rifle sideways, the case is thrown out. The extractor is returned by another spiral spring.

It has been stated lately that the Snider system was not really invented by Mr. Snider at all, but by M. François Eugène Schneider; or to go further back, by Mr. John Poad Drake, a Cornishman. But if we are really to trace the system to its source, we must go back to a time which places the invention quite beyond the reach of living men. I have not thus far ventured on the archæology of breech-loading; but if you will permit me, I will make one dive into antiquity for the purpose of bringing under your notice two breech-loading firearms of the reign of Henry VIII., on the Snider system!* By the kindness of Admiral Caffin, these interesting arms have been lent from the museum of the Tower, for the purpose of exhibition this evening.

In the course of the competition, the Snider gun proved about 50 per cent. quicker than its rivals; it was stronger too; it was simple, and

* For an illustration of such an arm, see Journal of the Institution, vol. ix, Plate xv, fig. 3.—Ed.

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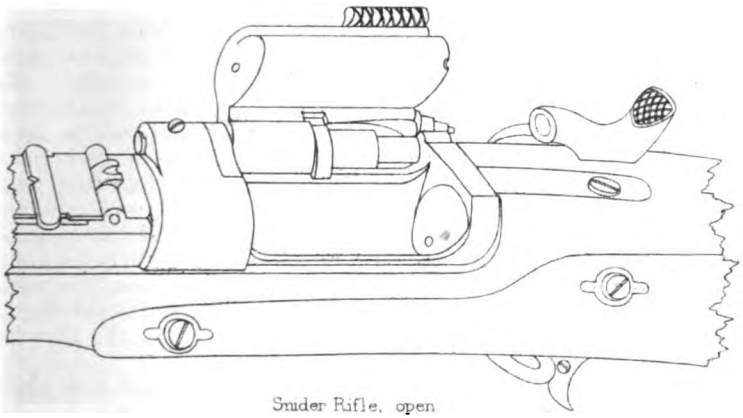
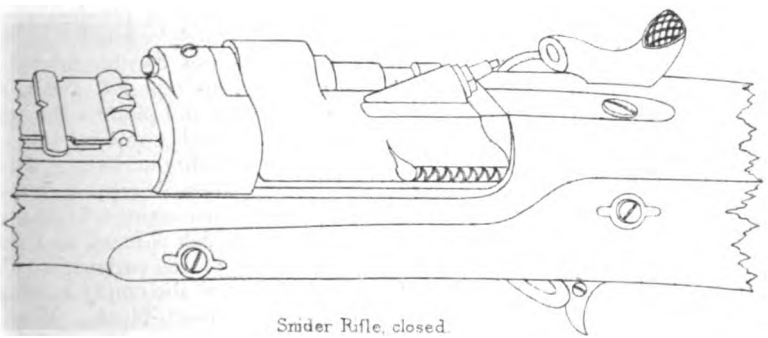
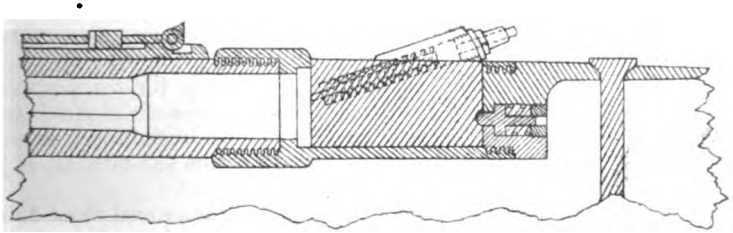


Snider Rifle, open



Snider Rifle, closed



Section through Snider breech action

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Fig. 1.
Mean Deviation = 1·56 Feet
or 18·35 In.s

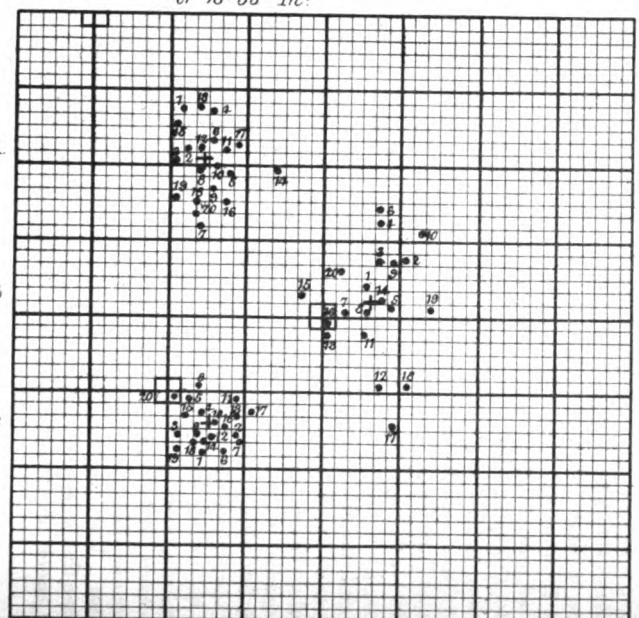

Fig. 1.

Fig 3

Fig 4

Fig. 2.
Mean Deviation = 4·69 Feet, or 56·25 In.s

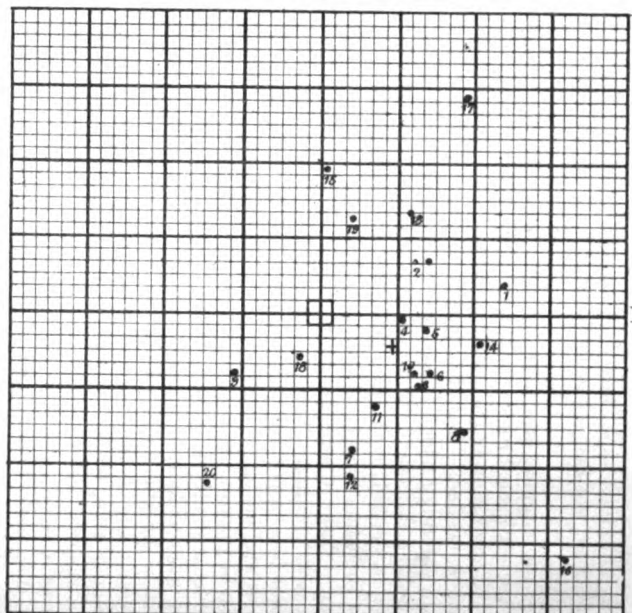

Fig. 2.

Mean Deviation = 1·07 Feet
or 12·85 In.s
Fig. 4.

Mean Deviation = 2·14 Feet
or 25·65 In.s
Fig. 3.

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apparently durable; and, lastly—I should perhaps have placed this advantage first, not last—it was adapted for a cartridge containing its own ignition.

Among the capping arms, the Mont-Storm rifle was ranked first, and was recommended for experimental application to a certain number of rifles. The system failed subsequently at proof, and the recommendation was cancelled. It failed partly on account of the unsuitability of the skin cartridge which formed part of the system; and this reminds me of another objection to which all capping arms are open. Such arms need a cartridge so thin, that the fire from the cap shall pierce it, and at the same time the cartridge must be so entirely consumed or carried out by the discharge, as to leave no residue to endanger or interfere with loading. These requirements make it difficult to satisfy another not less important point in a military cartridge, viz., that it shall be strong enough to stand the knocking about to which it will inevitably be exposed in transport and on service. Moreover, a thin cartridge is evidently less well adapted than a stout one to resist the effects of an accidental adjacent explosion. But the Mont-Storm rifle failed also in the arm itself. Under proof charges, the hinge and small bolt by which the chamber is locked, were broken.

The Snider rifle, while satisfying many requirements, failed in one important respect. It was so inaccurate as to be quite unsuitable for adoption as it stood.

These diagrams (Plate xii) will show you the extent of this inaccuracy. This one (Fig. 1) represents the mean shooting of an unconverted Enfield at 500 yards, the large squares upon the target being 3 foot each. Here (Fig. 2) we have some of the first shooting of the Snider rifle in the competition; here (Fig. 3) some better, although still bad, when a slight change had been made in the ammunition. At this point then, as the fault obviously could not lie in the barrel, the question of providing more suitable ammunition for the arm, was referred to Colonel Boxer.

Discarding the papier-maché case submitted by Mr. Snider, the objections to which, especially in damp weather, are well known, Colonel Boxer made the case of his cartridge of very thin sheet brass, ·003-inch thick. The cartridge has a little over two turns of this brass.

Five important advantages result from the employment of this case:—1st, Being uncoiled slightly by the explosion, instead of depending upon the mere stretch of the material, the case can be used in a chamber considerably larger than itself, with little danger of breakage and consequent escape of gas. 2nd, It is not liable to swell with damp, and so to interfere either with loading or withdrawal. 3rd, The difference between the size of the case and of the chamber is so considerable as to admit of loading even when the case has become considerably enlarged or disfigured by rough usage. Nor under these circumstances again, is there any danger of leakage or escape. 4th, Such a cartridge may be made, like the present service cartridges, practically waterproof. 5th, The reaction, or tendency of the case to recoil, which arises after the pressure of gas is removed, tends to render a case of this sort easier of extraction than any other. All of these advantages

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hold good against a papier-maché case; many of them hold good also against a case of simple copper or other metal. Cartridges of this last sort, have been extensively used in America. But the weight of bullet and charges used in that country is very much less than we are accustomed to require, and it is very doubtful how far such cases can be made, due regard being had to the three important considerations of weight, economy and easy extraction, strong enough to stand the strain involved in the use of our heavier projectiles and high charges. I am not speaking now, remember, of an universal cartridge, but of a cartridge adapted for the class of arms of which the Snider rifle is an extreme type, arms in which the cartridge becomes at the moment of firing just as strictly the breech or chamber of the gun, as this iron chamber in the gun of Henry VIII.'s reign. The only difference consists in the fact, that while in Henry VIII.'s reign, men preserved and reloaded their chamber, we throw it away after each discharge and take a fresh one; though, as sportsmen know, for economy's sake, we too sometimes use a chamber a second time, and refill it as often as it will serve us. My objections to copper cartridges are urged, however, specially in connection with this system or principle of breech-loading; but as regards papier-maché cartridges, we may, I think, speak more confidently, and pronounce against them a general verdict of disapproval for military use, on the grounds of want of durability and of the power to resist the effects of moisture.

The only change which has been made in the Boxer cartridge since its introduction, has been the substitution of a strengthened base, the details of which are shown on the diagram (Plate xiii) before you, for the original Potet base, which when manufactured in large quantities proved not altogether reliable. The ignition is that usually adopted in central fire cartridges, a small brass chamber in the centre of the base, containing an anvil, over which is placed the percussion cap. The expression "central fire" is applied to this arrangement in contradistinction to "pin fire," or to "rim fire," or to that method of ignition adopted in the Prussian system, which for want of a better name we may call "needle fire." By pin fire is meant the old Lefaucheux system which is generally applied in sporting cartridges, in which the anvil becomes, as it were, the striker and projects in the form of a pin. In rim fire cartridges, the fulminate is situated in the rim or flange of the cartridge, and although this construction presents undoubtedly certain advantages, it tends, by throwing some additional strain upon a weak part of the case, to produce fracture; and the Americans, who have hitherto been the main supporters of rim fire, are now, I believe, for this and other reasons, very generally substituting central fire, the details of which, however, would seem to be still open to considerable simplification.

The last point to be noticed in the ammunition for the Snider rifle is the bullet. On this the accuracy of fire of the arm depends. The bullet is not made, as in the majority of breech-loading arms, slightly larger than the bore, but depends for its action upon the system of expansion which Colonel Minié was, I believe, the first practically to adopt, viz., a hollow in the base, together with a plug, by which the original Minié iron cap has been superseded. This plug, which is

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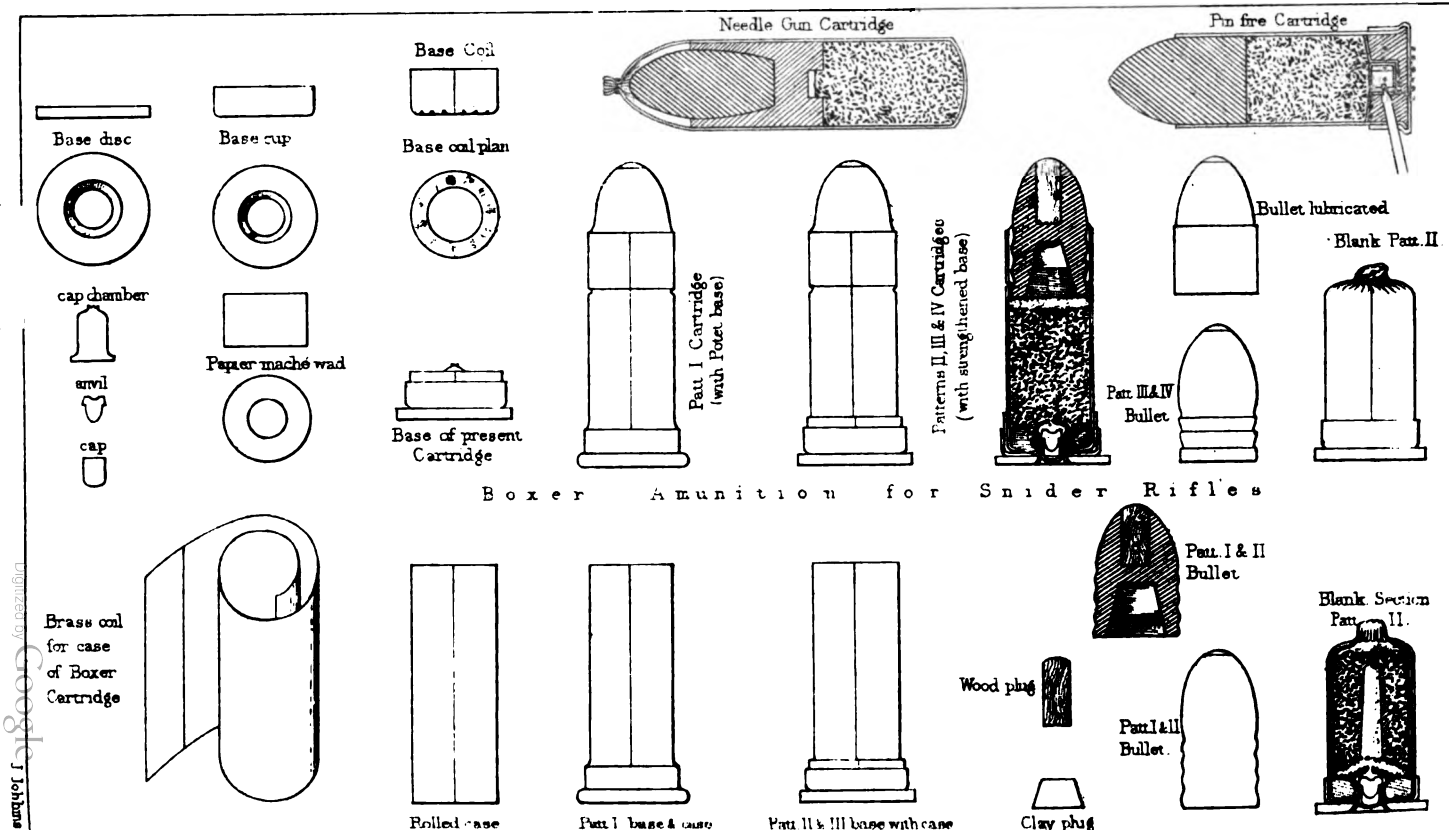

J. Johnson
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now made of baked clay, plays the double part of expanding and supporting agent. The expansion of the bullet would be effected, it is true, to a great extent by the simple action of the powder-gas upon the sides of the hollow. But a plug makes that expansion more instantaneous and more uniform; and, above all, it supports the sides of the bullet after expansion. Thus, with a plug, the passage of the gas is prevented and fouling diminished, in the first place; and, in the second, even when fouling has been established, its effect upon the accuracy of a plugged bullet, whose sides do not collapse when they come into contact with the obstructing deposit, will be much less than upon an expanded bullet which has no plug.

Another important feature of the bullet, is the wooden plug in the head. By this plug we obtain three advantages: greater length, and so a broader bearing and lubricating surface; secondly, the centre of gravity is more favourably adjusted with reference to the requirements of the projectile and the slow twist of the Enfield rifle; thirdly, the weight is disposed, as in the fly-wheel, away from the axis of rotation. This construction is well known in its common application to shell bullets, for which, indeed, it is a matter rather of necessity than of choice. Norton, Jacob, Dyer, Metford, and others, have all made use of it, and Mr. Metford and Mr. Whitworth have both employed it successfully for purposes of accuracy. It is important, however, to understand, that this feature by itself, does not constitute the essence of the bullet. It plays its part, together with the other features of the construction, and contributes its quota of accuracy; but the ultimate success of the projectile is due rather to the accurate adjustment and balance of the whole combination, than to any particular feature of the bullet taken singly. Those only who have followed the enquiry from its infancy can be aware of the nice points upon which the accuracy of shooting of this arm depends. Here, for example, are two bullets. Nine persons out of ten in this room would probably be unable to detect in them any note-worthy difference; and yet, one of these bullets shoots well and the other badly. And I would have you remark that the key to whatever difficulties have temporarily arisen in respect to the precision of the arm, is furnished by this explanation. It was because the accuracy depended upon the exceeding niceness of the combination—I am speaking now with reference not to the bullet only, but to the bullet in its relation to the arm and to the powder—that a loss of accuracy ensued, when that combination was departed from in the slightest degree, necessitating for the long Enfield the adoption of another bullet with a larger margin of efficiency.

Round the bullet are disposed grooves or cannelures, which serve to carry the bees' wax lubricant, by which means a layer of wax is always interposed between the lead of the bullet and the sides of the bore; and fouling is so completely got rid of, that one of the best targets ever made with this arm was made after 1,000 rounds had been fired from it without cleaning. This point is one of extreme importance, for the accuracy of a military arm is to be measured by its average accuracy during a long sustained fire, and not by its performances when perfectly clean. The measure of efficiency of a military arm in this, as in other

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respects, is to be obtained by taking the arm, not at its best, but at its worst. In other respects, the ammunition satisfied the tests which were imposed. It stood an extraordinary amount of rough usage. It was waterproof to an extent which enabled it to be kept for a whole week in wet sawdust without injury; it was easy of extraction; not liable to escape or explosion; and its expense is very little greater than that of a paper cartridge, even if we take its first cost merely, and immeasurably less, if we spread the cost over the periods during which the two ammunitions would respectively remain serviceable—if indeed, the paper cartridge could ever be considered serviceable. The extreme rapidity of fire in the arm is fifteen shots per minute. Of this ammunition about 11,000,000 of rounds were issued up to the close of the financial year, which ended last Saturday week, and of the arms 136,431.

To deal with the false and exaggerated reports which have been circulated respecting "the failure" of the Snider system, is a task which I cannot undertake, except in a general way. I can only say that in essence, and in substance, these reports are false. The system is to be considered from three points of view: as a breech-loader, as an arm of precision, and as a system of conversion. As a breech-loader—and every breech-loading system consists not of the gun merely, but of the gun and ammunition—the system has proved a most complete success. The percentage of casualties in this respect, as we gather from the reports of the troops in Canada, at Hythe, at Aldershot, has been absolutely inappreciable. For rapidity of fire, safety, simplicity, easy loading and extraction, and non-liability to get out of order, the system has proved all that was anticipated.

With respect to the rifle as an arm of precision, the difficulties which occurred for a short time, and which were experienced, it should be noticed, only with the long Enfields, have been easily and successfully overcome. It may tend also perhaps to restore confidence, if I state that lumping together the casualties of all sorts, grazes, mis-fires, split cartridges, &c., which have occurred out of a total of 94,840 rounds fired, up to the present time in the course of the ordinary daily proof, they amount only to 216, or under 1 in every 400 rounds. And the present accuracy of the arm is represented by this diagram (Plate xii, fig. 4). With respect generally to the system as a system of conversion, we certainly do not exaggerate its advantages when we say that it has given us, with the precision of the original Enfield rifle, from three to four times the rapidity of fire, at a cost of something below £1 per arm.

The progress made meanwhile by our neighbours, as far as I have been able to gather reliable information, is shown by this table.*

We are now able to observe the completeness which the question has for the moment attained. Having provided an effective arm for the *immediate* use of the British army, we are in a position to discuss calmly, although not too leisurely, the question of its *future* equipment, and you will judge, that materials for its consideration will not be wanting, when I state that the Sub-committee on breech-loaders have now before them, no less than 93 different systems from which to select the future arm of the British soldier.

* See Table on page 207.—Ed.

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I have collected a few characteristic specimens of the different modifications of which breech-loading is susceptible, and which will serve to illustrate the classification which I propose to attempt. It is of course impossible to exhibit these arms in detail; but, together with the very rich collection belonging to this Institution, they will be open to your inspection after the lecture.

Breech-loaders may be divided into two great classes:—(1) breech-loaders, in the ordinary acceptation of the term; and (2) repeaters.

The first class may be further subdivided into (*a*) chamber-loaders, and (*b*) breech-loaders proper. A chamber-loader is in fact a sort of muzzle-loader cut short, or so arranged that the arm can be conveniently loaded by hand, without the assistance of a ramrod. The charge is deposited in a short chamber, instead of being rammed all the way down a long barrel; and the chamber is then replaced in the position for firing in the prolongation of the barrel. Of breech-loaders on this plan there are many modifications. In the Mont-Storm arm, the hinge is in front of the chamber; in many rifles (the Swedish Hägstrom for example) it is behind, and that would probably be the most primitive form of chamber-loading. Colt's and Deane and Adam's revolvers are examples of chamber-loading arms having several chambers. In these arms, the chambers are not hinged, but revolve, and are brought in succession into prolongation of the barrel. I have several other examples of chamber-loading arms here, to which I would invite your attention after this discourse. There is a Spanish arm (Garcia's), Bergstrom's, and another Norwegian system; Leetch's, Mackenzie, and Wentworth's, Lechmere's, Standermayer's, and many others which I cannot even find time to mention.

The more conspicuous defect of this class of arm would seem to be their liability to injury by the explosion, which generally acts directly upon the breech mechanism. On the other hand, they are generally perfectly free from escape of gas, except sometimes at the junction of the chamber and barrel. In Sweden and Norway, chamber-loaders find more favour than in this country.

Breech-loaders proper include more numerous types of arms. The Snider rifle is an arm of this class; so is the Westley Richards, the Terry, the Sharp, the Green, the needle-gun, all of which you have seen. I have here several others, some good, some bad, some celebrated in their way, and some which exhibit the imperfections of which the system is capable. The Amsler-Milbank system (adopted by the Swiss Government for conversion), Joslyn's, Bayliss's, Restell's, Beard's, Burton's, Prince's, the Starr carbine (now in use in Canada), Fosbery's, Laidley's (adopted in Russia), are all examples of breech-loaders proper. In these arms, as a rule, very much more work is thrown upon the cartridge. Where, as in the needle-gun and the Sharp carbine, the escape is sustained by the gun, and not by the cartridge, the system will generally be open to objection on the score of excessive escape of gas. With secure ammunition, this defect may be entirely got rid of; and to me it seems sounder in principle and more reliable in practice to throw the burden of the escape upon the cartridge, which

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only has to sustain it once, than upon the arm, which must sustain it many thousands of times.

Repeaters may be subdivided into (*a*) revolvers, and (*b*) magazine arms. Of Revolvers the best examples are furnished by revolving pistols, of which, by the addition of a long stock and barrel, rifles have sometimes been made. I have here also a revolving carbine, by a Colonel Porter. The system is open to many objections, among which, except for pistols, the weight of the several chambers is conspicuous.

Of Magazine arms there are two important varieties: The simple repeater, such as Henry's, in which the cartridges are constantly drawn from a magazine under the barrel, which must be replenished from time to time as it becomes exhausted; and secondly, an arm which, like the Spencer and Lamson rifles, can be used as repeaters or as simple breech-loaders at will. In these arms I can, if I wish, shut off the magazine, and load them as ordinary breech-loaders. This plan presents several important advantages over the ordinary repeater, which entails distinct intervals of inefficiency while the magazine is being replenished, and which directly tempts the soldier to indulge in an excessive rapidity of fire while his magazine supply lasts. But in the improved repeaters, these objections are obviated. I have here, for example, the Lamson rifle, with its magazine full. I need not, however, call upon the magazine, but I may load as if the arm were an ordinary breech-loader. Then when pressed, I can, so to speak, turn on the tap of the magazine, and pour forth such a fire as no simple breech-loader can deliver. When my magazine is exhausted, I am not, as with an ordinary repeater, temporarily disabled, for I can fall back upon the simple breech-loading action, until an opportunity presents itself for replenishing the magazine against another emergency. So with the Spencer rifle, in which, as you will see from this diagram (Plate x, fig. 3), the magazine is situated in the stock.

The direction in which repeaters generally err, is in complexity of construction; but if this defect can be overcome, a magazine-rifle would present immense advantages over the simple breech-loader, not merely for those services, such as the navy, the cavalry and artillery, in which an intensely rapid fire is generally required for a few decisive moments, but for the universal equipment of troops. It is in arms of this class, that breech-loading tends towards its highest development; and to this principle of action I believe we must look for the ultimate solution of the breech-loading question.

In selecting from the numerous systems of breech-loaders one for military use, certain general considerations must always be observed. Rapidity of fire is of course essential; and so should be perfect safety and freedom from escape of gas. The arm should not be easily liable to injury from rough usage, fouling, damp, or the action of discharge. Facility of loading and extraction are merely necessary elements in rapidity of fire. Close fitting, or broad sliding surfaces are to be avoided. A moderate degree of accuracy combined with lowness of trajectory, and penetration should be insisted upon. The ammunition should be safe, durable, if possible waterproof, perfectly reliable and

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serviceable in different climates—and *after* all this (not before) as cheap as you like. And these conditions require to be satisfied not merely on the parade ground or in the showroom, but under the severe tests to which in actual warfare, the system will be exposed. The problem viewed in this light will appear—as I would have it appear—less easy of solution than is popularly supposed.

The advantages which breech-loading presents in a military rifle are—

First, *Rapidity of Fire.* We give each soldier, so to speak, and as I have before expressed it, three or four rifles, with the inconveniences only of one. At close quarters no troops, however brave, devoted, or disciplined, could stand with muzzle-loaders against a corresponding force armed with breech-loaders. It amounts to being opposed to a force whose numbers are practically multiplied by the figure which expresses the ratio of rapidity of fire of the breech-loaders to the muzzle-loaders. We must not press this argument too far. It will hold generally when the fighting is quick and close and decisive, and when the conditions of the contest on both sides are the same. But breech-loaders will not do everything; and we must avoid the error of supposing that they did everything in the Danish or Bohemian campaigns. The needle-gun was but the embodiment of that spirit of "*geist*" and progress which animated the Prussian army and its leaders, which dictated the execution of their rapid movements, and which was the soul and essence of their superior organization. Especially must we avoid the too close application of mere abstract reasoning when the element of artillery fire comes into play. Eleven years ago an experiment was made at Hythe with life-size dummy figures of men and horses, which went to prove conclusively that artillery would be beaten off the field by infantry armed with rifles. This drawing, (Plate xiii) shows what was then proved, that a detachment coming into action would be annihilated in three minutes by thirty file of riflemen. But two important considerations were overlooked: that in actual warfare, infantry would scarcely deliver so effective a fire as then served to plant at 800 yards' range, thirty-four shots in a single gun detachment,—just as two men standing opposite one another at twenty paces to fight a duel, often fail to hit one another, while at a very much greater distance they can each easily break a bottle's neck in a pistol gallery. And, secondly, the necessity for artillery coming within this range at all, was not established; so that the reasoning which was based upon these premises fell in practice to the ground; and notwithstanding improved musketry instruction and improvements in the arms, the use and importance of artillery have in nowise diminished since the introduction of the rifle for general service: so these also would be mistaken who might argue from this diagram that if so much could be done with muzzle-loading rifles, firing as they did on this occasion one round per minute only, breech-loaders firing seven or eight rounds per minute would produce a corresponding effect, and that the predominance of artillery fire in an action must henceforth cease to exist. But within reasonable limits, the effects of breech-loaders, as opposed to muzzle-loaders, can hardly be over-

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estimated, It must be remembered too, that there is always attendant upon the employment of a more effective arm, a moral as well as a physical effect. As Marshal Marmont said, a battle is decided after all, not by the number of men killed, but by the number frightened.

By a converse application of this argument, we reach the second advantage of breech-loading, *increased confidence*, a point upon which I need not dwell, but of which all military men will recognize the importance.

Thirdly, we obtain greater *facility in loading*. On horseback, breech-loading, even of an imperfect kind, is obviously vastly superior mechanically to muzzle-loading. For the infantry soldier, if we reflect a moment, the advantages will appear quite as great. Whatever the soldier's position, whether lying behind some sheltering mound, cramped in a rifle-pit, working in close squares, with his bayonet presented to resist cavalry, or running forward as a skirmisher, he can load a breech-loader as he could never load a muzzle-loader—without exposing himself, without changing his position, without inconvenience or loss of time or effect.

We have, in the fourth place, *improved shooting*. The arm is always loaded in a position which favours the subsequent delivery of a low and effective fire. The eye is never removed from the object; and no part of the powder can be spilt, no part can be lodged in the grooves of the rifle; while the increased confidence of which I have spoken tends to steady men's arms and improve their aim. It has been objected that the rapid firing of the breech-loader will tend to tire and unsteady man's arms, but surely this objection, if it has any force, may be met by the consideration, that the operation of loading a breech-loader is very much less fatiguing.

Fifthly, *the possibility of overloading is avoided*. This, in the hurry and excitement of action is no uncommon accident. A man loads and as he thinks fires. His cap misses fire, or he even neglects to cap at all. But he does not at once recognize it. He rams down another charge; perhaps another, &c. &c. After one of the American battles, several arms were picked up loaded with two charges, others with three; some with four, and a few even with eight!

Among the minor advantages of breech-loaders, I may name the completeness and compactness of the ammunition; the facilities for cleaning and inspecting the arms; the ease with which the drill may be acquired; the diminished danger in loading; and the impossibility of the arm being rendered inefficient by the loss of a ramrod.

It has been said that breech-loaders will entail an excessive expenditure of ammunition. But in the first place, we have no grounds for supposing that the ammunition expended, will be *wasted;* and a similar argument would have held against the supersession of the old flint-lock by the percussion cap. If the fire be delivered at such ranges that the shots tell, it merely amounts to this, that the work is done with the new system so much quicker and more effectually than with the old; and experience teaches us that the requisite supply can be kept up without difficulty, even in a long hot general action, and that this objection has been much overrated. It is stated indeed that

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the greater coolness and confidence of the men tend rather to a less expenditure; and the comparatively small number of rounds fired by any individual Prussian soldier in the late campaign, if figures are to be relied upon, would seem to favour this view. The supply of ammunition, however, whatever its expenditure, is only a question of organization; its *efficient* expenditure is a matter of instruction.

BREECH-LOADERS

Already adopted, or in Contemplation by the different Military Powers.

	System of Conversion.	New Arms.	Remarks.
England ..	Snider	Not Determined	
France.. ..	Nil	Chassepot	
Austria ..	Wänzel	2,000 Remington's Ordered for Trial	The New Arm not finally decided.
Prussia ..	Nil	Needle Gun	
Spain	?	?	
Portugal ..	?	Westley Richards	
Sweden ..	Nil	Högstorm	It is said that Sweden proposes to adopt the Remington for future manufacture.
Norway ..	?	?	
Belgium ..	Snider	Not Determined	Several Arms under trial.
Switzerland ..	Amsler—Milbank	Winchester	
Turkey ..	Snider	Lamson	The new arm uncertain, but Lamson has been named as probable.
Russia.. ..	Terry	Laidley	
United States..	?	Berdan Spencer	
Canada ..	?	Peabody Starr Spencer	
Italy	?	Westley Richards	Large numbers ordered.

The CHAIRMAN: Gentlemen, this is a subject that very often entails a difference of opinion; but I think there can be no difference of opinion as to the talent

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Capt. Majendie has displayed in the paper which he has read to us this evening. At the same time there may be different remarks and opinions which gentlemen may wish to express, and which I am quite sure Capt. Majendie, and every one else present, will be glad to hear.

Colonel EVELYN: As no gentleman appears desirous of coming forward, I rise to make a few remarks—not to express a difference of opinion from Capt. Majendie, for I think I agree with almost every word of his lecture. But I think there was one point of view which is generally lost sight of in the consideration of the great advantages to be obtained from the breech-loading gun. I think we shall never attain the full advantage of quick loading till we get rid, in some manner, of the smoke. The great advantage to be obtained at present from the breech-loading system does not depend on the rapidity of fire, but on the ease of loading, and upon the fact that the man is, as you may say, never unloaded. Now I have stood in front of a line of men firing blank cartridge, and after the second round not a man in the line has been able to see me. That proved that even with muzzle-loaders the fire in line was too quick. But supposing the spot I occupied had been occupied by an opposing body of troops armed with guns firing with some smokeless material, their fire would be directed by the flashes of the opposing guns, and they would be able to fire as accurately as if there had been no smoke at all. In point of fact, it is the smoke caused by the firing of one's own gun that obstructs one's view, not the smoke of the enemy. Therefore the attention, I think, of all men interested in this subject should now be directed not so much to the improvement of breech-loaders, as to the attainment of a smokeless compound. We shall never get the full advantages of quick loading till we get that. One of the dangers we ought now to avoid is that of loading our men with an enormous quantity of ammunition. It does not follow, as I think the lecturer observed, that there should be any increased number of rounds fired in consequence of troops being armed with a superior weapon. If so, in what does the superiority consist? If it requires a greater number of rounds to produce the same effect, it would be rather a proof that the weapon is not superior. I doubt whether there would be any greater number of shots fired in action than there used to be; but I know the system that has hitherto obtained with regard to the second and third supply of ammunition has been very inefficient in our own and other services; but I believe that has been immensely improved. I maintain that fifty rounds per man is as much as a soldier ought to be loaded with, until we very much reduce the weight of our cartridges. The American troops during the last war were only armed with fifty rounds, and I do not see why there should be more. Remember, the soldier has to march with his ammunition; he has to go on guard; he has perhaps to carry that ammunition for a month, day and night, before he fires it; and to add two or three pounds to the weight in that particular, would impede very much his efficiency. I think it would be a great pity, if we were to have all sorts of extra belts and accoutrements for the purpose of supplying our unfortunate infantry soldiers with extra ammunition, when the first reserve should always be at hand. The quantity of ammunition the soldier carries, should be influenced entirely by the quantity he can bear without inconvenience, and not by the number of rounds he may have to fire in a general action, for the first reserve should always be at hand.

General ABBOTT: I should like to ask Capt. Majendie a question with regard to a statement which I did not quite understand. It was with regard to the precision in firing of the bullets used for the present arm. I have understood that two descriptions of bullets are required; one for the short rifle and one for the long. Under these circumstances, would there not be great inconvenience experienced in serving out the ammunition for the short and for the long rifle? It appears to me there would be a good deal of inconvenience occasioned, and I should like to hear what explanation Capt. Majendie can give.

Brigadier-General LEFROY, R.A., F.R.S.: I can, I think, Mr. Chairman, answer that question. It is the fact that the bullet used in the long Enfield is a 480 grain bullet. Now, that does not shoot quite so well with the short Enfield as the 528 grain bullet originally introduced, but the difference is so small that it would be quite unnecessary to perpetuate two ammunitions for the sake of it. The difference does not amount to more than two or three inches at 500 yards distance, which, I think, most practical men will think quite near enough.

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Captain STRANGE, R.A.: I wish to make a few remarks with reference to what was said by the first speaker as to reducing the weight of the ammunition. It might be, that the size of the bullet may be considerably reduced, because we know that a man in hospital is worse than a dead man, and a wounded man also has to be carried to the rear. Not only that, but there are two fellows always very ready to carry him to the rear, and sometimes another might go with his cap. That has been remarked before. I do not mean to say, of course, that British soldiers are at all addicted to this kind of thing in general. The remark would be only applicable to those opposed to our fire. The fact remains, that wounded men are a greater incumbrance to an army than dead men, who are very easily got rid of. We must, however, consider that the bullets, if made smaller, might not be effective as regards horses. I just mention those two points because they have not been alluded to.

Capt. GOODLIFFE, City of London Rifle Volunteer Brigade: I wish, Sir, to ask one or two questions. First, I think the Lecturer stated that the cost of the present ammunition, as settled for the Snider rifle is equal, if not much in excess, of that at present supplied for the Enfield rifle. I do not know that I understood him distinctly on that head, but I thought that was one of the points he insisted upon. It appears to me to be a very important one indeed. A second question also is, that the Government seem rapidly to have taken up the conversion of the Enfield rifle, without any reference whatever to improving its construction, beyond making it a breech-loader. It has long been held by those acquainted with the Enfield rifle, that it fails in one or two most important particulars, which might easily be remedied without any detriment to the arm itself, and would produce much greater accuracy in shooting. I allude of course to the inefficiency of the twist; that is to say, the twist is made too slow to enable a bullet to be carried at long range with anything like accuracy. Another point is with reference to placing the back sight of the rifle so far to the rear. At the present moment it requires considerable practice before it can be efficiently used. The back sight is probably the most clumsy and senseless contrivance that could possibly be suggested, because it is impossible to take that accurate aim which might easily be obtained by a blackher slide, which, indeed, is usually adopted in match rifles. There appears to be no reason why these improvements should not be carried out with reference to the Snider rifle. But we must, I think, first of all make up our minds whether or not mere accuracy of aim, or mere rapidity of fire, is all that is to be desired. If you want accuracy of shooting, you will never attain it with the practice at present given to the British soldier. Not being a military man myself, I am not able to state the reasons why; but if the accuracy of the aim is to be of any importance, as I apprehend it will be more and more so, it will be necessary to give a certain contingent out of every regiment, a much higher degree of qualification and instruction than they have at present, because the small amount of practice which the soldier has, is quite insufficient to render him a practical and skilled marksman. It appears to me you must first of all obtain something like accuracy in the weapon, and then give that instruction which will enable the soldier to use it efficiently. I see no reason why this should not be done with the Snider rifle, but the difficulty at present is in the cost of the ammunition, which seems a very formidable one, and unless it can be shown that the ammunition can be constructed at a much lower cost than we have already heard stated, it will be a very serious objection. I have not heard any answer to those very remarkable letters which appeared in the public press from General Hay, with reference to the bad shooting of the Snider rifle. It is perfectly clear that in a military weapon, low trajectory is an important feature, and according to General Hay's statement, the trajectory was not only much too high, but the bullets went, as he very forcibly expressed it, "nowhere." Now, if the Government is going to convert rifles at an enormous expense, the bullets of which are to go "nowhere," and the trajectory which, as far as it can be ascertained, is "anywhere," it seems to me to be a very serious mistake. No doubt the Lecturer will be able to give us some explanation, but, coming from so high an authority as General Hay, it is a question demanding the most serious consideration, and if General Hay's statement be true, it appears to me to be almost fatal to the success of the Snider rifle, as a weapon of accuracy.

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Mr. G. Daw: I should like to ask whether Capt. Majendie considers these specimens (the specimens on the table) of a perfect cartridge, and whether they are the cheapest that have been furnished? I ask it because I see a great variety of breech-loaders have been shown, but we have only one specimen of cartridge. I must say I think it would have been a little more to the enlightenment of the company if we had had a variety of cartridges also. As the matter stands at present, one would suppose that that was the only cartridge that had been introduced. I make these remarks for this reason, that as I was the pioneer of that system into this country, I certainly should like to have seen the different principles fairly discussed if time had permitted, because Colonel Boxer has thought proper to christen that cartridge with his own name, and I think it is important to us as ratepayers to find out whether we have really in the service, the best and cheapest cartridge.

Mr. Clark: I wish to offer a few remarks upon one part of this subject which I believe is admitted to be of very great importance. I refer to the cartridges which play as important a part in breech-loaders as the gun itself. There were two distinct descriptions of cartridges; those with metallic cases, waterproof and capable of being submitted to rough usuage, and the ordinary paper cartridge. I think in this discussion the properties of the two cartridges, their respective cases, ought to be taken into consideration. The difference of expense between the two cartridges is very considerable, and one that bears heavily upon the finances of the country. It has this importance, that a difference of expense in the gun itself, once incurred, is done with, but the difference in the expense of the cartridges is everlasting. It is imposing a great outlay upon the expenditure of the country. Now I am able to go to figures with some degree of accuracy in the case of the two descriptions of cartridges. It is pretty well known by volunteers—that is a test of what the real cost of the cartridge is—that the paper cartridge for the muzle-loader is delivered at 5*s.* per hundred, 6*d.* for the packet of ten. And it has come to my knowledge that the volunteers have heard with great dismay that when the day for arming them with breech-loaders shall come, and of course that day is not far distant, they will have to pay, instead of 5*s.* per hundred, 10*s.* per hundred for their cartridges. Now if we go into that question in a broad point of view as applied to the expenditure of the country, the importance is really of very great magnitude, and we may say in general terms, that the difference of cost between the two cartridges is £2 per 1000. Now as a million of cartridges is composed of a thousand times that number, there is no less a difference than £2000. In the last session it was stated in the House that forty millions of cartridges were ordered for breech-loaders, and if we apply the figure I have just mentioned £2000 per million, there is £80,000 difference of expenditure for the article of cartridges alone. Another point bearing upon the same question which was very aptly referred to by a gallant Officer on the other side of the theatre, is the weight of the cartridge to be carried by the soldier. Now the difference between the ordinary paper cartridge and the "Boxer" cartridge is very considerable. I see by the printed notice to inventors and gun-makers calling upon them to enter into competition, one of the conditions is that the weight of the metallic cartridge of the breech-loader is not to exceed six pounds four ounces for sixty rounds. I believe that weight was the weight of the "Boxer" cartridge before it was found to be too weak to stand the force of the explosion, the weight has since then been considerably increased, and I believe I am not wrong in saying the sixty rounds now weigh, instead of six pounds four ounces, about seven pounds. Perhaps that may be a little above the mark, but at all events the weight is considerably increased. The difference in weight will amount to about a pound and a-half between the paper cartridge and the metallic cartridge. That, you will admit, is very considerable. I wish to draw your attention to those two points—the cost of the cartridge and the weight which certainly bears in a very important point of view upon the question we are discussing.

Capt. Selwyn, R. N.: I beg to move the adjournment of the discussion, convinced as I am that there are many persons here present who desire to offer still further remarks, as indeed I do myself. I am not at all disposed, however ably the paper has been put before us, to allow many of the statements to pass uncontradicted. I beg therefore to move the adjournment of the discussion.

The Chairman: I do not know that we can call upon Captain Majendie or any

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one else to attend again because we may wish to have an adjourned meeting. Captain Majendie is kind enough to come here to-night, but I do not know that we can ask him to attend again.

Captain SELWYN: It has been the rule hitherto in this Institution that whenever a paper has occupied so much time as not to leave a reasonable time for discussion, which in this instance only amounted to about a quarter of an hour, that course has been followed. Therefore I am not, I think, out of order.

The CHAIRMAN: Not the least out of order. Is there any seconder?

The motion for the adjournment was seconded by Captain Moncrieff.

The CHAIRMAN: I think the point to settle, first of all, is whether we can call upon Captain Majendie to come here again to answer questions. I myself do not think it is quite right, when a gentleman volunteers to come to read a paper, that we should prolong the discussion on it. The lecturer is quite willing to answer anything that can take place in the course of the hour, but I do not know that we can ask him to come here again for the purpose of continuing or answering a discussion. That is my impression.

Captain BURGESS: I rise, Sir, to say that our discussions have often been continued till nearly eleven o'clock at night.

The CHAIRMAN: It depends very much upon the time of gentlemen. We must not go beyond a certain reasonable hour. At the same time I have no doubt Captain Majendie will wait. I hope you will not be too long.

Captain SELWYN: I am sorry that I am so ill as to be almost unable to speak to night. However, I think the question is of the highest importance, and that if the public are left under the impressions which Captain Majendie's lecture would give them in very many points they would be uninformed, and in still more points they would be misinformed. First as to the accuracy obtainable by the Snider rifle. Now this has been made one of the features of excellence supposed to belong to this particular system, brought forward in a very peculiar way. To those who know what the principles of artillery, are I need only affirm, I am sure they will support me in saying it, that the shooting is due to the barrel and projectile, that if you had your chamber containing your gas a mile off from your barrel and had the same force of gas, the same projectile, and the same barrel, you would get exactly the same shooting as if the chamber was part of the barrel as long as there was no escape of the gas. Therefore, the mode of enclosing the gas as long as the gas does not escape, does not matter one iota, unless you adopt any particular form which is best calculated to throw the gases in the proper direction. That is the only thing that can make a difference. The history of the Snider rifle is a very peculiar one. A Committee was appointed, and it was laid down as a principle to start with by that Committee, that self ignition cartridges were utterly to be despised and condemned. Under those conditions, that competition took place, and it was only from America that there came certain systems of self-ignition cartridges, which were, when first examined, thoroughly laughed at, and were not accepted at all. I hold here in my hand a report of that Committee which distinctly awards the palm in every respect, save that of self ignition, to the Mont Storm rifle. I presume that those Mont-Storm rifles were tried by the usual proofs, and I do not think the Committee have usually been in the habit of trying any rifle that has not been subjected to proper proof. Many thousands of those arms have been manufactured less than the average number bursting in proof; I am not an owner or the inventor of the Mont-Storm system, but simply anxious for fair justice to every one, of the number of those guns proved amounting to many thousands, rather less than the average per centage burst. Since these competitive trials, the Committee take occasion to compliment Mr. Mont-Storm on the perfection to which he has brought his rifle, and to say in all respects, except that of self-ignition, it is the one they recommend. It appears rather late to say now, that the rifles failed in trial, which they did not do till long after all these trials had been gone through. It appears very strange instead of saying, "Can you give us one thing more, and then we shall be quite satisfied,—that is, self-ignition?" instead of doing that, they turned round to the very worst rifle, one of the most complicated, one that had been condemned and refused by every other government in Europe before it was brought here, and by adding to it Mr. Mont-Storm's shoe,

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which was shown to them by the manufacturer of the Mont-Storm rifles, by adding to it various other little plaisters here and springs there, they at last brought out a rifle which according to the recent reports, as just now remarked, has a trajectory "anywhere," and shoots "nowhere." It does not always do so; how is that? The lecturer tells us in his hands it has accomplished a wonderful accuracy, but I should like to know what was the diameter of the bullet employed? Was it the ordinary Enfield ammunition to which the rifles were restricted that fired during this competition, or was it an ammunition specially constructed for it with a bullet of a larger diameter, with very little windage, which will make any rifle shoot better up to a certain point, and which is a thing which ought never to be lost sight of, seeing that windage was introduced to patch up a difficulty which we found in loading our rifles? The bullet is made up, it appears, of wood in front, wood in rear, and lead distributed about the body, and is supposed to shoot better than a lead bullet. I should like to know, if that be the case, why we do not fire some metal that has low specific gravity? What is the reason we have always chosen lead, the material having the greatest specific gravity? It seems to me that if I take a cork bullet and fire it out of a rifle I shall get a very high trajectory, and I shall reach a very short distance, and the bullet will be nowhere. That will be the only result of diminishing the specific gravity of any projectile, while I left its diameter the same or rather increased. That is one of the laws of artillery that I do not think anybody will contest. Then it appears that the cartridge was not quite satisfactory even after the change was made from the original cartridge proposed by Mr. Snider, to the cartridge manufactured by Colonel Boxer,—that was not satisfactory, for the base expanded a little too much,—that is to say, it exploded occasionally. And, more than that, another thing was, that as the mechanical conditions are unfulfilled in the extractor, that is to say, that you do precisely what no boy would think of doing if you were to give him a box of sugar plums and asked him to take one out,—put his finger without his thumb down at the side; you put your extractor on one side of the case, a thing which is known to be a fallacy to every sportsman who has used a central fire cartridge for the past three or four years or more; you pull at one side of your cylinder, you push it over on your chamber, and you get an unsatisfactory extraction. To meet that you patch on a little bit of brass, but that happens to weigh something, and you find that your cartridges exceed the weight you allowed to the competitors; and so you proceed ingeniously to lighten the ball. That is one way out of the difficulty, of course if people like to take it; but I do not think it is in accordance with any correct principles, and I am quite sure that if we pass from the cartridge to the arm, we shall find we have gone far from taking the right principles. We have taken a portion of the barrel and practically thrown it away, and we have now placed the ball, instead of being where it ought to be, two inches farther forward, two inches up the barrel, so that the ball lies under the sight. Still farther, we have coned out the barrel towards the rear, which is about as bad a proceeding as we could adopt, in order to facilitate the withdrawal of the cartridge. Thus they have patched up little difficulties one after the other. The question of price has been so very ably dealt with by Mr. Clarke, that I shall not refer to it at all. I merely recognise the correctness of his figures. £2 per thousand is the difference in price. What the difference in cost is at Enfield it is impossible to say, because I do not know whether interest on capital or depreciation of plant are taken into consideration; but to the volunteer it amounts to this, that when he has fired away a thousand cartridges he has fired away the cost of two guns. That is about the history of it. If you can get a solid punched metal cartridge which will obviate the difficulties of the present one, there is no earthly reason for retaining all those folds of metal and bits of paper, pasteboard, and one thing or the other which mount up to fourteen different parts in the construction of that cartridge. If you ask the Americans here to-night, they will say that they go in for simplicity, and so long as they can punch their metal they prefer to do that to having a folded sheet, putting paper over it, a cap, and a bell cup, and an anvil, and a bit of pulp to keep that in them—putting three brass bases at the end, and calling it a perfect cartridge. What we ought to go in for, is *first principles*, and not this or that invention. I understood Captain Majendie to say that with regard to paper cartridges, he considered them as totally

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out of the field by the fact of their liability to injury by explosion or by damp. Now I think perhaps he will limit that remark as regards explosion, if the thickness of the paper be increased. I should say then that probably the paper cartridge may be as little liable to explosion as the metal cartridge, because I know the paper will bend and allow itself to be deformed as much as the metal. But there is another difficulty when we come to the thicker cartridge, and that is that you increase necessarily the size of the chamber, and those objections must be overcome before we can allow it to take its place in competition with perfectly punched metal cartridges, which I am convinced can be made by the manufacturing skill of this country in any shape that is desired. Now the expediency of meeting the transition state of things which Captain Majendie has very ably put, and for providing for the case in which our soldiers may either be called upon to fire loose powder and ball or special cartridges, is one which no doubt deserves great attention, and ought not to be neglected. It is possible to fulfil both those conditions, to give the soldiers an arm which will be equally well able to fire with a cap and loose powder and ball or with its own special cartridge, giving the very highest rate of firing and the lowest price of cartridge. The question as to the Prussian needle guns and the other guns which have been brought here this evening, has, I think been very ably disposed of, showing that those foreign guns have been surpassed in this country. We need not waste time in considering any of those arms which firing a non-metallic cartridge that is blown away, have an imperfect gas closure, and throw the strain of the explosion on the gun and not on the cartridge, for the whole of those difficulties are at once met by the fact of the substitution of the metal cartridge in whatever form we may have it. I think I may lay it down as an axiom that we must have a metal cartridge of some description, and I hope to see it introduced as well for sporting purposes as for the work of the army. To the Volunteer, the question of refilling, is an important one. If you have cartridges which can be refilled five or six times, it reduces the price of his cartridges practically below the price of the paper cartridges which he had before. That will be a very important point to fulfil, and that also I believe can be done with punched metallic cartridges. I now draw attention to the question of increased accuracy, and I beg to say I would take the arm which made that target and put on to it any one of the breech mechanisms which do not admit of any wasteful expenditure of force by the escape of gas, and I would get precisely the same shooting from it under the same conditions of barrel and projectile. Therefore it should not be considered that the chamber of the gun has anything to do with the shooting of the weapon. We have been told that this was a mere question of a stock in trade. Now I mean to say, a proper breech-loading arm, such as has been offered to the Government before now by various parties, all meritorious more or less, would be capable of having 20 or 30 barrels screwed into it as fast as the rifling was destroyed or worn out; and therefore it should never have been regarded as a question of the stock already existing. We might have had the very best arm as a conversion as well as we shall have it two years hence. There is only one other point I wish to refer to, and that is the liability of the gun to destruction at sea. Now you are going to supply us, as the result of this competition, and you are supplying us as the result of this conversion, with a rifle to be used as well at sea as on shore. I lay it down without fear, as an uncontradictable principle, that no spiral spring will ever stand at sea. You may have a rifle for six months exposed to a sea atmosphere and see no change; all of a sudden you take it out and you see your springs are snapped. This was spoken of not long since in this Institution by Captain Colomb, who found that he could not rely upon steel spiral springs, and that even brass spiral springs could not be relied upon. After the lecture on that evening was over, Mr. Nock, the celebrated gunmaker's son came to me and said: "Sir, I can only say my father would never allow me to put a spiral spring in a gun." Those are matters of experience not to be lightly despised, which I think should occupy the attention of Government before they allow any unnecessary complications to be introduced in the rifle which has to win our future battles, as far as small arms can do it by sea and land. The other parts of the Snider rifle are also exceedingly liable to displacement. I do not say they are so in such a gentleman's hand as Captain Majendie's, who, like myself, has probably had fire-arms in his hands from

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boyhood, but in the hands of the common soldier. First of all, if there is any gas escape—and the best manufacturers of cartridges in the world cannot turn out a thousand cartridges, one of which may not have gas escape—if there is any gas escape at all, the result is, the pin is blown back and the breech-block is blown open, which in fact occurred the other day with the Snider rifle in Belgium at Government trials. They tried damaged cartridges and the result was, that every Snider breech-block they tried, was blown open by the explosion of the the gas. I do not at all agree with Captain Majendie's idea that the hammer holds the breech down. It does not do so in the slightest degree. If the striker is blown back at all, the result is, that the hammer is raised, the whole of the breech block arrangement slips from under it and the breech blows open. I know several accidents have occurred from that cause. Then there are three spiral springs that we have to deal with, and I shall perhaps be told that they are not important. Certainly they are an objection; every additional piece of mechanism is an objection. Then again we have an extractor, and although it may be very cleverly managed with a sham cartridge, yet when you come to load and fire that gun, you find in nine cases out of ten you have to make three motions; first, to draw the extractor back by hand, secondly, to release it, and then if you are lucky it will go forward, but if it is a little rusty, it won't. Next you have your cartridge back about an inch, and then you find you have to put your finger to take it out. It is very nice to exhibit experiments, and to tell us that used in practised hands at Woolwich this has not occurred, but I know it has occurred in many hands, and it will occur again, and if you can extract without any such arrangement you will have done very good service. I have touched as far as I could on the cartridge and also on the arm. I will not detain you longer except to observe on the fact that for some reason or other, the ramrods are retained in these guns up to the very latest date of competition. I hope it may be made the subject of some thought, whether for the theoretical advantage of spitting a fowl, or cleaning a barrel which you ought not to want to clean except by a common bit of string and a bullet, or for hooking cartridges out when they stick, which we have heard it has been greatly used for at Woolwich, it is worth while to retain a ramrod. I have heard one man say that out of sixteen cartridges he had to push twelve out of the barrel with the aid of the ramrod, these were only experimental ones of course, but I hope, however, it will be considered whether it is worth while for these purposes to carry a ramrod in a breech-loading gun. If we are to carry more cartridges with a breech-loading gun, then we can do so only by diminishing the unnecessary weights, and we could diminish the weight of the gun so much as not to make the increased weight of the cartridges sensibly felt.

Major-General BOILEAU, F.R.S.: I wish to ask one question with reference to the calibre, whether on general principles any approximation to the future calibre of our breech-loading rifles has been adopted. I mention this because the calibre of our rifle is the largest of all breech-loading rifles in use at present. The Americans adopted a rifle with half an inch calibre, and the Chassepot has a calibre of ·433. There is a Chasseport rifle in the room which has been brought over by Mr. Christy. I believe it is the only one in England, and it is a rifle of Mr. Chassepot's own manufacture. There are also two rifles of recent American invention by Mr. Hammond, which Mr. Daw has brought, and perhaps Captain Majendie will not object to their being exhibited, either now or by and by. I think we have had as regards "the present of breech-loading rifles," a most lucid and interesting paper from Captain Majendie, a paper which although I have for nearly seven years been dabbling in rifles, has given me food which I do not expect to digest before the next lecture comes off in this Institution. I think also as regards future rifles that the Committee have quite enough before them in studying the 93 patterns lately sent in, and I have no doubt they will give us the best they can. But the question of calibre has not been mentioned this evening, and it appears to me to be one by which the future of breech-loading rifles will be greatly affected. I shall be glad to hear therefore whether any approximation to the future calibre of breech-loading rifles has been agreed upon.

[Mr. CHRISTY here exhibited a Chassepot rifle, and said it was a specimen *of the*

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actual arm adopted by the French Government, of which 10,000 had already been issued to the French troops. After describing its mechanism very briefly, and having illustrated his description by taking the breech of the rifle to pieces, he said that the French Government had decided to do away with all screws that could be at all troublesome to a man in a camp after a day's campaign. He had heard that the spiral spring was objected to by some gentlemen, but the spring was so thoroughly protected in the Chassepot rifle, that it was not at all objected to in France.*]

Captain C. O. BROWNE, R.A.: There is one question Captain Selwyn brought forward, which I think should be answered, as it had reference to Artillery. He said that if it was imagined that by having wood in the centre of a bullet it would shoot better, the same argument would hold good for making the bullet entirely of wood or cork. Now, if he had been an Artilleryman, I should have appealed to him to ask whether he did not know it was a fact that a rifle shell carries much more truly than a shot.

Captain SELWYN: To what range?

Captain BROWNE: To any range.

Captain SELWYN: Certainly not; you ought to be artilleryman enough to know that.

Captain BROWNE: At all events, we will say that at most ranges the shell carries more truly. The inside has shellac, air, and powder, an artilleryman would hardly argue from that that a projectile of the density of air, powder, and shellac would shoot better still. Had he said he was a mathematician I should have told him the "radius of gyration" was lengthened in a hollow bullet. I think he did say he was a mechanic and an engineer. Mr. Whitworth is a mechanic and he seems to have found out that a hollow bullet shoots best. It has been said to-night that the spin of the Enfield rifle is too slow already; in order to keep up the spin the weight is placed outside. Any engineer who wishes to keep up rotation by a fly-wheel places the weight round the edge of it; it would not be exactly the same thing to put the weight in the middle and spokes outside.

The CHAIRMAN: Mr. Abel, who has had a good deal to do with gun-cotton, will perhaps, be kind enough to tell us what is going on with reference to that substitute for gunpowder. It is important as bearing upon the question of freedom from smoke.

MR. ABEL, F.R.S.: As far as absence of smoke is concerned, gun cotton will carry all before it, but there were so many points to be worked in connection with its application to small arms for military purposes, that although I have been somewhat persevering in working at this subject, and although many others who have studied it and are interested in gun cotton, are very sanguine indeed as to its eventual application to military purposes, still I feel that at the present moment I have nothing that would be sufficiently valuable to bring before the Society with regard to its special application to breech-loading arms, that would warrant my detaining you to-night. I may say, however, that I am most sanguine as to the eventual application of gun-cotton to breech-loading arms for military purposes.

Captain MAJENDIE: When I selected this particular phase of the question this evening, I was in hopes that we should have limited the discussion as much as possible to facts and have avoided theories, because it is impossible in a lecture of this sort to deal with the abstract theories of gunnery, and although it would doubtless be very interesting to discuss questions of gunnery with Captain Selwyn, we

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* The following additional information has been supplied since the meeting.

All the parts are interchangeable and have a great deal of play. The barrel or breech is choked or rendered gas-proof by the expansion of an ebonite ring or washer. The action of the gas is on a steel disc and not on the ebonite. The weight of the rifle is under 9 lbs., and the bore is ·433 of an inch. The cartridge is made of paper, and is all consumed or passes out at the muzzle. The ignition is in the cap and a needle strikes the composition, after passing through a small elastic washer. The cartridge can be made up by an ordinary soldier, should the regular supply of ammunition fail.—ED.

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cannot do it satisfactorily or usefully here. Therefore, I propose to deal as far as can with the simple questions of fact which have been raised in this discussion. With regard to the calibre, I really am unable to give an answer to General Beilson's question because I do not belong to, nor have I any connection whatever with, the Committee who have to decide upon the introduction of the new arm. There is no doubt a sort of impression prevailing that the arm will certainly be of smaller calibre than the present, and perhaps taking one view and setting it against another view, half an inch may be considered the better calibre. Of course that is a matter of opinion. It is a question for the gun-makers, and it is open to them to submit whatever plans they like.

Now as to the question of accuracy, we have been told that the Snider rifles shoot nowhere, and that the trajectory is anywhere. I can hardly do better than read the last report of General Hay's, which I have with me, in which he says, "I have the honour to report for the information of his Royal Highness that the shooting at 600 yards and at 800 yards is better than that of the muzzle-loading rifle of 1853." That is General Hay's opinion about the shooting of the Snider rifle. On the question of trajectory, I have been carrying out some experiments lately. General Hay gives the trajectory in one of his experiments at about thirteen minutes difference in favour of the muzzle-loading Enfield at 600 yards. Now I make out that at 300 yards the Snider is equal, and at 500 yards—I certainly used different powders on these occasions*—the Snider, instead of being thirteen minutes inferior, was three minutes and five seconds superior to the Enfield rifle. At 860 yards the lightness of the ball began to tell, and we got a difference only of twenty-two minutes as against the Snider rifle. Therefore, I think, if these experiments were repeated—I am quite satisfied my own have been made carefully with fixed mechanical rests—we should probably find, as might reasonably be expected, that at moderate ranges, at 500 or 600 yards, the trajectory of the Snider rifle would be slightly superior, while at 800 yards it would be very little inferior.

The question of penetration has been raised, and I can only say that the penetration of the Snider rifle at fifty yards is only ·3 of an inch below that of the Enfield rifle; that is to say, the ball will pass through 10·8 half inch deal boards, while that of the Enfield rifle passed through 11·4 half inch deal boards. So much for the questions of accuracy, trajectory, and penetration.

Then with regard to the question of cost. Gentlemen seemed to suppose I was comparing the present ammunition with the old 1853 ammunition. That is quite a mistake. I did not intend to compare it with that when I said that the present cartridge is very little superior in first cost to the paper cartridge, I meant the papier-mâché breech-loading cartridge. A breech-loading cartridge is necessarily more expensive than a muzzle-loading cartridge; but even if we take the figures as compared with the old Enfield rifle cartridge, I dispute the statement that the difference is £2 per thousand, and say it is not more than 19*s.* 1*d.* a thousand, which will make a large difference in the gross calculation of £80,000. But with regard to the other question of expense, as between different sorts of breech-loading cartridges, this must always be subject to the question of efficiency. I have started by saying that certain conditions must be satisfied in a breech-loading cartridge, and I think there is no gentleman here this evening who would be inclined to dispute it. I made it as wide as I could in order to avoid disputes. When you have satisfied these conditions, not before, then you may begin to think of expense.

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* The following explanatory note has been forwarded for insertion:—"Different powders having been used at the 300 and 500 yards ranges, the symmetry of the result is spoiled. Theoretically the Snider, having the lighter bullet, should have a lower trajectory at both these ranges; but in this experiment it was lower only at the 500 yards range, but not higher, only equal at the 300 yards range. This apparent discrepancy might seem to establish some error in the experiment or calculation, in absence of the true explanation, viz., that the powders used at the 300 and 500 yards ranges were different."—ED.

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With regard to the copper cartridges, which are of the ordinary type, there are three important things to take into consideration, the weight of the cartridge, the economy of the cartridge, and the extraction of the cartridge. If you make a cartridge very thin, so that it expands very much, you get into difficulties with certain arms in the extraction; if you make it very thick, you get into difficulties of expense or weight. It was stated, I think, in the course of the discussion, that at Woolwich we do not calculate capital or plant and depreciation of plant, or cost of ground, or cost of materials which we use. I may say distinctly, having been five years in the Royal Laboratory, that we charge every one of those things. We charge cost of the ground for the building to stand on, we charge depreciation of the plant, and of the buildings in which the manufacture is carried on. We have a balance-sheet which is based precisely upon ordinary commercial principles, and which will enable us to place our charges in direct comparison with those of any commercial firm.

Captain SELWYN: What profits do you charge?

Captain MAJENDIE: I cannot recollect at this moment the exact figures, but we have a regulated scale of depreciation of plant.

Captain SELWYN: Do you charge any profits, and if so what percentage?

Captain MAJENDIE: We bring out the ordinary cost of the material of the thing which we are producing at ordinary price.

Captain SELWYN: What ought volunteers to be able to get a cartridge for?

Captain MAJENDIE: I believe the price at which we produce the present "Boxer" cartridge, taking all these things into consideration, and taking the cost of powder, which has been calculated on a greatly increased rate lately, is £3 13*s.* 6*d.* per thousand.

A MEMBER: How many grains of powder do you calculate for each cartridge?

Captain MAJENDIE: 70 grains. There was one question about weight. It was stated that we defined the weight for the new competition at 6 lbs. 4 ozs., and that the present cartridge was very much in excess of that weight. Now the weight of sixty rounds of the present ammunition is 6 lbs. 2 ozs., which is 2 oz. within the rate laid down for the competition. Sixty rounds of Enfield ammunition weighs 5 lbs. 11 ozs., while sixty rounds of Snider ammunition does not weigh 7 lbs., as has been stated, but 6 lbs. 2 ozs.

The CHAIRMAN: Whatever difference of opinion there may be, and difference of opinion in a meeting of this sort brings out perhaps very valuable discussion, there can be no doubt of this, that the giving of these lectures, whether by any person in authority or by any person who is kind enough to come, who is not in authority, to give us the result of his experience, is most valuable to the Officers both of the Army and the Navy, and to those gentlemen who come here and listen. Therefore I think you will all agree with me that Captain Majendie is entitled to our best thanks for his kindness in giving this lecture.

P.S.—A change has been made in the construction of the ammunition for the Snider rifle, with a view to reducing the cost of production. The quantity of brass in the coiled case has been reduced to 1¼ turns; brown paper has been substituted for white; the base-cup is made of thinner brass; the base-coil is replaced by a thin cup; the base-disc is now made of iron; and a slight alteration has been effected in the bullet, which, although retaining the weight of 480 grains, has now 4 canelures, and is better adapted for use with the short Enfields and naval rifles, than the pattern of bullet which it replaces.

Ammunition embodying these improvements is distinguished by the numeral V.

9th July, 1867. V. D. M.

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Evening Meeting.

Monday, April 1st, 1867.

VICE-ADMIRAL Sir H. J. CODRINGTON, K.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 18th March and 1st April, 1867.

ANNUAL.

Middleton, Francis D., Maj. 29th Reg. £1.
Burgoyne, R. dhu H. G., Lieut. 93rd Highlanders. £1.
Moray, H. E. H. Drummond, Lieut. Sco. Fus. Gds. £1.
Majendie, Vivian D., Capt. R.A. £1.

ON THE ECONOMY OF FUEL, COMPRISING MINERAL OILS.

By Professor W. J. MACQUORN RANKINE, C.E., LL.D., F.R.S., &c.

This paper contains no new principle, nor any new series of experimental researches. It is an attempt to state in a compendious shape the scientific principles that regulate the economy of fuel—a shape in which they may be conveniently applied to any experimental data that now exist, or that may hereafter be obtained.

In the first place I shall have to make a few preliminary remarks on the most convenient way of expressing quantities of heat for such purposes as the present. For purely scientific purposes, the ordinary unit of heat is so much heat as raises by one degree the temperature of the unit of weight of water, whatsoever the unit of weight may be. In British measures, the ordinary unit of heat for scientific purposes is the quantity of heat which raises the temperature of one pound of water by one degree of Fahrenheit's scale—say from the temperature of 39° Fahr. to that of 40° Fahr. When we say that during a certain process—the burning, for example, of one pound of a certain sort of fuel—so many units of heat are produced, we mean that by means of that process, if there be no waste of heat, so many pounds of water have their temperature raised by one degree.

I have here made a memorandum as to the ratio of the British unit and the metrical or French unit, because the employment of French measures for scientific purposes is so common that it is important that their relation to British measures should be borne in mind, especially now that their use is permissive in this country.

One degree centigrade = 1·8 degree Fahr.;
One kilogramme = 2·2046 lb.;
therefore, one French unit of heat = 1·8 × 2·2046 = 3·968 British units.

Connected with this mode of expressing quantities of heat, is the

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mode of measuring such quantities in delicate scientific experiments; and that is by the instrument called the Water Calorimeter, where there is a certain mass of water, and a process is performed, such as burning a certain quantity of a combustible substance, and the temperature of that water is raised. Then, knowing how many pounds of water there are in the calorimeter, and knowing how many degrees its temperature has been raised, we can calculate the quantity of heat which that water has received. That is a process which, simple as it may look at first sight, requires great care and delicate apparatus, to ensure accuracy. There is one circumstance that is a fruitful source of inaccuracy, or would be so but for the precautions that are used to avoid it; and that is, the temperature not being uniform throughout the different parts of the mass of water. We have a vessel containing a certain quantity of water; we have a thermometer at one point in that vessel, and that thermometer shows a certain temperature. But the temperature in other parts of the vessel may be quite different. It is necessary, therefore, that the water-calorimeter should be provided with an "agitator," like a screw propeller, for stirring or mixing all the particles of the water intimately together, and for ensuring so constant a circulation in every part of the calorimeter, that the whole of the water shall be at one temperature.

Then there are always certain causes of waste of heat at work. The water in the calorimeter loses heat by conduction, and heat is carried off by the escape of the hot gases produced by the combustion; and the losses of heat which thus occur have to be measured and to be allowed for.

The measurement of heat, then, by the calorimeter is suitable for a scientific laboratory; but on account of the minute precautions that it requires, it can scarcely be considered practicable in such a way as to be trustworthy in experiments on a great scale.

As an instance of the way in which errors may arise in that mode of measuring heat, suppose that we have a certain boiler containing water, and that we apply some heating process to that water until bubbles of steam begin to come from it under the ordinary atmospheric pressure. We should run a risk of serious error if we assumed that the whole mass of water was at the boiling point. The upper stratum of water may be at that temperature, and may be giving out bubbles of steam, but the lower strata of the water may be at lower temperatures; and we may be led to form most erroneous estimates of the quantity of heat given out during the process if we conduct the experiments in such a manner as that.

For practical purposes, connected more especially with the steam-engine, the most convenient unit of heat appears to be the *unit of evaporation*; that is, so much heat as evaporates a unit of weight of water under the mean atmospheric pressure of 14·7 lbs. on the square inch, the water being supplied to the boiler at the same temperature at which it is evaporated; that is to say, at the *standard boiling point* of 212° Fahr., or 100° cent. It is a perfectly definite unit of heat, and one that is easily measured and easily identified.

Then, in certain respects, it is identical in the measures of all

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countries whatsoever. There is no question about different standards of weight or measure, when we speak of the number of units of weight of water that are evaporated at the standard boiling-point by a unit of weight of a given sort of fuel. That number is precisely the same whatsoever the system of measures we employ, whether British or French, or the system of any other nation.

The British unit of evaporation is this:—The quantity of heat that evaporates one pound avoirdupois of water at the standard boiling-point of 212° Fahrenheit, or 100° centigrade—the feed-water being supplied to the boiler at the same temperature at which it is evaporated. It is equal to 966 ordinary British units of heat: that is 966 times the quantity of heat that raises the temperature of 1lb. of water 1° Fahrenheit. The French unit of evaporation is the quantity of heat that evaporates one kilogramme of water at the same standard boiling-point, and it is 537 ordinary French units of heat.*

Now, that is a unit of heat specially convenient for purposes connected with the practical employment of fuel. For one thing, it avoids the use of large numbers. That may seem, at first sight, a trifling matter; still, it is of considerable convenience in practical calculations, that we have to deal with units and tens, instead of thousands and tens of thousands. Another advantage is, that we have the heating powers of fuel expressed in terms of the practical effect that fuel is most frequently employed to produce. A third has been already referred to; viz., independence of special systems of weights and measures in expressing the heating powers of fuel.

Connected with the expression of quantities of heat in units of evaporation, is the experimental measurement of such quantities by means of the evaporation of water; and here, too, certain precautions must be observed in order to ensure accuracy. In the first place, the condition that the water shall be "fed," or supplied to the boiler at the boiling-point, must either be exactly fulfilled, or any deviation from it must be ascertained and have its effect allowed for. In practice, the feed-water is almost always supplied at a lower temperature than the boiling-point. Then the water is not evaporated under the standard atmospheric pressure; and a further correction is necessary, depending upon the difference between the actual boiling-point and the standard or atmospheric boiling-point.

With regard to the way in which the temperature of the feed-water and the temperature of the boiling-point affect evaporation, I may refer to the following formula:—

$$E\ (\text{reduced}) = E\ (\text{observed}) \times \left\{1 + \frac{T_1 - T_f + 0{\cdot}3\ (T_1 - T_f)}{966\ \text{F. or } 537\ \text{C.}}\right\}$$

* It is well known that a certain quantity of heat is equivalent to a certain quantity of mechanical work. For instance, we require to expend 772 foot-pounds of work in friction, in order to raise the temperature of 1 lb. of water 1° Fahr. If we multiply 772 by 966 we get the number of foot-pounds of mechanical work that we have to expend in friction, in order to evaporate 1 lb. of water: so that, to evaporate any given weight of water by mechanical work alone, we require to perform as much work as would lift the same weight up to the height expressed by the product; that is, 745,800 feet, or 227,309 metres, nearly. This is the dynamical equivalent of an unit of evaporation.

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In the first place, you observe that the formula expresses this:—A certain weight of water has been actually evaporated, the feed water being supplied at some degrees lower than 212° Fahr., and possibly the boiling point being some degress above 212°. I denote that weight by "E (observed)."

Now, in order to express this result in standard units of evaporation, we must reduce it to what the weight evaporated would have been had the feed water been supplied at 212° Fahr., and had the evaporation taken place at that same temperature; a weight denoted by "E reduced." For that purpose we must multiply the observed evaporation by 1 + a certain correction. And that correction is got at in this way. Let T_1 denote the boiling point, 212 Fahr. standard, and T_f the temperature of the feed water. Then $T_1 - T_f$ is the number of degrees by which the temperature of the feed water is below the standard boiling point. Let T_b stand for the actual boiling point; from that we subtract the standard boiling point T_1, and take three-tenths of the difference, viz., $0{\cdot}3\,(T_b - T_1)$. Upon this quantity depends the additional expenditure of heat, owing to the actual boiling point being above the standard boiling point. And having added together those two quantities, the depth of the temperature of the feed below the standard boiling point, and three-tenths of the height of the actual boiling point above the standard boiling point, we divide by 966 if the temperatures are taken on Fahrenheit's scale, or by 537 if on the centigrade scale, and we get a certain quotient, generally a small fraction; we add that to unity, and we get a factor by which we multiply the observed evaporation, and the product is the "reduced evaporation."

If the actual boiling point has not been observed, it may still be calculated from the pressure; because there is a connection between the boiling point and the pressure, and the boiling point corresponding to a given pressure may be ascertained by means of formulæ or tables.

Besides this, great care must be taken that the true weight of water evaporated is ascertained. We must either take care that the boiler does not prime, or we must ascertain the amount of priming and allow for it. Priming is the carrying over of water in the liquid state, in the form of spray or mist, along with the steam. Supposing that in the apparatus used it is impossible to avoid priming, there is only one resource: that is, to use an apparatus which will stop all the liquid water from passing, and let nothing but the dry steam pass, and then condense the dry steam in a separate vessel and weigh it. That is scarcely practicable on a great scale, and in the rough sort of way in which many such experiments must be made; and therefore in such cases we must rely chiefly on taking care either that there is no priming, or, if that be impossible, that it is so small as to be unimportant.

Having explained the precise nature of the unit of heat which I intend to use, I will now speak in the first place of the *total* or *theoretical* evaporative power of a given sort of fuel, that is to say, the number of times its own weight of water that it would evaporate at the standard temperature, if there were absolutely no waste of heating power; and in the second place, of the *effective* or *available*

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evaporative power, being what we actually get with such furnaces and boilers as we have at our command.

I may observe that the ratio which the effective evaporative power bears to the total evaporative power is a fraction which we may call *the efficiency of the furnace and boiler*. For shortness, we will call it the *efficiency of the furnace*. If the whole of the heat employed by combustion could be effectively employed at the standard temperature, without any waste whatsoever, we should have an evaporative power represented, say by E. But the actual evaporative power is a smaller quantity, say E′: then we have the ratio,

$$\text{Efficiency of furnace} = \frac{\text{E′ (available)}}{\text{E (total)}},$$

which is a fraction less than unity; and the nearer that fraction approaches to unity, the more efficient the furnace and boiler are.

With respect to those two quantities,—total evaporative power, and available evaporative power, it may further be remarked that the total evaporative power of a given sort of fuel depends upon its chemical composition alone; while available evaporative power depends not only upon the chemical composition of the fuel, but upon the construction and mode of management of the apparatus in which it is used, upon the supply of air, and upon a great variety of different circumstances.

With regard to the total evaporative power of different sorts of fuel as distinguished from the available evaporative power, we already possess very full and accurate information. Numerous careful experiments on that subject have been made in scientific laboratories; they have consisted in completely burning small quantities of different combustible substances, and measuring the heat with scientific apparatus of a very accurate kind, and taking special care that no heat escaped measurement. For example, in such experiments it has not always been practicable to prevent hot gases, the products of combustion, from passing away at an elevated temperature. But then the volume of those gases and their temperature could always be measured, and the heat that so passed away by the chimney calculated and allowed for. It is from experiments of that sort that our knowledge of the total or theoretical evaporative power of various combustible substances is derived. Many such experiments were made by Dulong, Despretz, and other chemists and natural philosophers, from which a great deal of valuable information was obtained; but the experiments now chiefly to be relied on are those of Messrs. Favre and Silbermann, published in the *Annales de Chimie et de Physique*, for 1852-3, volumes 34, 36, and 37. Those experiments have furnished us with a body of information which, as to combustible bodies that are of any practical importance, leaves nothing to be desired: that is, as to total or theoretical evaporative power. Our knowledge of available evaporative power is still imperfect: much has been learned, but much still remains to be learned.

I will now make some remarks specially upon the total or theoreti-

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cal evaporative power of certain sorts of fuel as ascertained by the experiments to which I have referred.

We may distinguish the combustible substances to which those experiments relate into two classes—elementary substances and compound substances. I have stated the theoretical or total evaporative powers of the only elementary substances that are of any practical importance in this table :—

Element.	Oxygen per unit of weight.	Air per unit of weight.	Units of evaporation.	
(1) Hydrogen gas	8	36	64·2	
(2) Carbon, solid	2⅔	12	15·0	
(3) Carbon, solid, with half supply of oxygen	1⅓	6	4·5	15·0
(4) Carbon, gaseous, in 2⅓ parts of carbonic oxide	1⅓	6	10·5	
(5) Carbon, pure gaseous (inferred by theory)	2⅔	12	21?	

You will observe that there are three columns of figures following the name of the elementary substance. The first expresses the weight of oxygen that is required in order to burn completely an unit of weight of that elementary substance. For example, 1 lb. of hydrogen requires 8 lb. of oxygen for its complete combustion. In order to supply that oxygen there are 36 lb. of air required; and in the second column of figures is stated the weight of air. The third column gives the total or theoretical evaporative power, which in the case of hydrogen is 64·2 times its own weight. It has the greatest evaporative power of all known substances. Then follows carbon. A pound of carbon requires 2⅔ lb. of oxygen to burn it completely, and to supply that oxygen 12 lb of air are wanted; and the complete combustion of carbon produces heat enough to evaporate 15 times its own weight of water.

I may here observe that carbon exists in various states of aggregation, such as charcoal, coke, plumbago, and diamond; that the experiments of Favre and Silbermann were made upon it in those different states, and that the total heat of combustion differs according to the state of aggregation. The more hard and dense the carbon is, the less is the heat we get by the combustion—the reason evidently being that a certain quantity of that heat is expended in overcoming the attraction of the particles of carbon for each other. For example, diamond does not evaporate so much as 15 times its weight of water, because of the heat required to overcome its own cohesion. That has a bearing upon some other phenomena to which I will presently refer. But the quantity I have here set down is the result obtained from carbon in the ordinary states of charcoal and coke.

The third line in the table refers to the result produced by carbon when burned with only half the full quantity of oxygen. It is known to chemists that carbon combines in two different proportions with

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oxygen. One part of carbon by weight combined with one part and one-third of oxygen produces carbonic oxide. Carbonic oxide is itself a combustible gas, and in burning it combines with just as much additional oxygen as it already contains, so as to form carbonic acid. If we have a furnace ill supplied with air, so that the carbon only gets half the quantity of oxygen that it needs in order to form carbonic acid, then we have carbonic oxide as the product. Each pound of carbon takes up $1\frac{1}{3}$ lb. of oxygen, and to supply that oxygen 6 lb. of air are required. The total evaporative power is diminished not merely to one half, but to a great deal less than one half: it is only 4·5, or three-tenths of 15, the total evaporative power with a full supply of oxygen.

If we next take that carbonic oxide, the weight of which will be $2\frac{1}{3}$ lb., namely, 1 of carbon, and $1\frac{1}{3}$ of oxygen, and burn it, it takes an additional $1\frac{1}{3}$ lb. of oxygen to burn it; and we get exactly the quantity of heat necessary to make up the deficiency, namely, $10\frac{1}{2}$. The $4\frac{1}{2}$ units of evaporation during the first process and the $10\frac{1}{2}$ during the second, give 15 in all, making up the whole evaporative power of carbon with a full supply of oxygen.

A conclusion can be drawn from this, which I will now explain. It is to be observed that in both those stages of the combustion of carbon, we have the very same thing happening chemically; we have $1\frac{1}{3}$ lb. of oxygen combining with 1 lb. of carbon. But there is this difference in the two stages. In the first stage, where the carbonic oxide is produced from solid carbon, the solid carbon has to be converted from the solid state to a state of vapour or of gas. In the second stage, we have the carbon already in the state of gas. Hence it appears that the cause of difference between the $4\frac{1}{2}$ units of evaporation due to the first stage, and the $10\frac{1}{2}$ due to the second stage of the combustion, must be, that during the first stage, 6 units of evaporation disappear in transforming the carbon from the solid to the gaseous condition: in other words, the *latent heat of evaporation of carbon is six times that of water*. Thus we arrive at the conclusion, that the total evaporative power of pure gaseous carbon is 21, from which if we subtract 6, the latent heat of evaporation of carbon, there remains 15, the total evaporative power of solid carbon.

I have marked that conclusion as to the total evaporative power of gaseous carbon with a note of interrogation (?), because it is a theoretical inference which has not been directly verified by experiment, but only deduced by reasoning. Still it seems to me that there can be little doubt of its truth.

If we could get pure carbon from any natural source in the gaseous state, we should have 21 units of evaporation by burning it, because we should save the six units that are employed to transform the carbon from the solid to the gaseous state—that is, those six units would be available for the evaporation of water.

So far, then with regard to the total or theoretical evaporative power of the elements of fuel.

Now, as to that of their compounds.

It was at one time supposed, from experiments relied upon at the

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time, that on order to calculate the total evaporative power of a given compound, we had only to take the separate elementary substances of which it consisted, calculate the separate evaporative powers due to those constituents, and add them together. But in the present state of knowledge we know that such a result as that is not quite accurate: that we require to subtract whatsoever heat may be necessary to separate the constituents of the compound fuel from each other. There are cases where apparently there is no sensible expenditure of heat for that purpose. But in almost every actual case that we meet with, it is evident that a certain quantity of heat disappears in overcoming the attraction of the constituents of a compound fuel for each other. So that having calculated from our data regarding elementary substances the theoretical evaporative power due to the combination of the elements of a compound fuel with oxygen, we must not stop there, but we must subtract whatsoever heat may have to be expended in order to overcome the affinity of those elementary substances in the compound fuel for each other before they can combine with oxygen.

Having premised that, I may call attention to some results of scientific experiment as to the total evaporative power of certain kinds of compound fuel.

The only compound fuels that are of any practical importance are the compounds of hydrogen and carbon. It appears from the experiments of Favre and Silbermann, to which I have referred, that in the case of marsh-gas, which is a compound of two equivalents of carbon with four of hydrogen, or by weight, three parts of carbon to one of hydrogen, we have the following results:—

Constituents.	Equivs.	Parts by weight.	Oxygen.	Air.	Evaporative power.	
C	2	¾	2	9	11·25	calculated as if solid.
H	4	¼	2	9	16·05	
C_2H_4		1	4	18	27·3	sum
		Evap. power by experiment			24·3	
				Difference	3·0	

Three-fourths of the weight of marsh-gas is carbon; one-fourth is hydrogen. Now if we calculate the evaporative power by taking the constituents separately, we get three-fourths of 15, or 11·25 for the carbon, if solid; one-fourth of 64·2, or 16·05, for the hydrogen; making together 27·3. But the total evaporative power is found by experiment to be 24·3; so there is a disappearance of three units of evaporation, over and above a quantity equal to that which would disappear in evaporating three-fourths of an unit of weight of carbon, viz., $6 \times \frac{3}{4} = 4\frac{1}{2}$. That is evidently due to some affinity between the carbon and the hydrogen, which has to be overcome in order to separate them from each other; and which requires, in order to overcome it, the expenditure of $4\frac{1}{2} + 3 = 7\frac{1}{2}$ units of evaporation.

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Then, in the case of olefiant gas, one of the chief constituents of coal-gas, we have—

Constituents.	Equivs.	Parts by weight.	Oxygen.	Air.	Units of evaporation.
C	4	6	2·29	10·30	12·9 { calculated as if solid.
H	4	1	1·14	5·13	9·2
C_4H_4		1	3·43	15·43	22·1

Here, calculating the total evaporative power from the constituents as before, we find it 22·1; and that is exactly verified by experiment. Still that very fact is itself a proof of the disappearance of some heat in separating the carbon from the hydrogen; because it has to be recollected that in coal-gas the carbon is gaseous; and if we get no more heat from the carbon in coal-gas than we get from solid carbon, it proves that as much heat disappears in separating carbon from hydrogen in coal-gas as is required to evaporate the same quantity of solid carbon.

That is a fact of much importance, and it simplifies considerably the calculation of the total evaporative power of various hydrocarbons; for the calculation for olefiant gas, which I have given by way of example, is not a solitary instance. By applying a similar method of calculation to the experiments upon various compounds of hydrogen and carbon, it would appear that the expenditure of heat in separating the carbon from the hydrogen is, at all events, to a very close approximation, the same as that required to convert the carbon from the solid to the gaseous state. Hence we get for all practical purposes a good approximation to the evaporative power of any such compound except marsh-gas, by taking the evaporative power of each unit of carbon in the compound as 15, and of each unit of hydrogen as 64, and then adding the results together. That has been verified for an immense variety of compounds. It does not hold with mathematical precision, but it holds with a degree of precision that is enough for any practical purpose.

Now as to the effect of the presence of oxygen in fuel. It was established some time ago by the researches of Dr. Joule, to whom science is immensely indebted for many discoveries of a similar kind, that a certain and definite quantity of heat is produced by the union of two chemical elements, and that precisely the same quantity of heat disappears in the separating of those elements. He verified that in a great number of cases, and established it as an universal law of nature. It holds in many other processes besides chemical combinations and decompositions, whether we are speaking of heat or of any other form of physical energy, that whatsoever quantity of energy we obtain by a given process, if we exactly reverse that process we have to expend precisely the same quantity of energy again.

If 8 lb. of oxygen combine with 1 lb. of hydrogen, they produce heat enough to evaporate 64 lb. of water. If we decompose that water by any contrivance, whether by the use of a galvanic battery, by

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the superior affinity of carbon for oxygen, or by any other process, precisely the same quantity of heat disappears in overcoming the attraction of the hydrogen and oxygen for each other. Now if oxygen enters into the chemical composition of any fuel, we have this result: calculate how much hydrogen that oxygen requires in order to form water—that is to say, one-eighth part of the weight of oxygen; then the oxygen present in the fuel renders just that quantity of hydrogen unavailable for the production of heat, and takes away from the total evaporative power 64 times the weight of the hydrogen so rendered unavailable. That being known, we have the following rule in the shape of a formula:—

$$E = 15\,C + 64\,H - 8\,O.$$

This, then, is the rule for calculating the theoretical evaporative power of any sort of fuel whose combustible materials are carbon and hydrogen from its chemical analysis. Distinguish the constituents into carbon, hydrogen, oxygen, and refuse. The refuse does harm as being a useless weight, but it does not take away from the heating power of the constituent parts that remain. For every unit of carbon that remains in the compound, we have 15 units of evaporation; and for every unit of hydrogen, in the absence of oxygen chemically combined with it, 64 units of evaporation; and if there is oxygen in the compound fuel, we have to subtract eight times the weight of that oxygen, because the oxygen renders inoperative one-eighth of its weight of hydrogen; and one-eighth of 64 is 8. The remainder gives the total evaporative power of that fuel.

The next formula shows the amount of air necessary in order to supply oxygen for the complete combustion of a compound fuel. It consists of 12 units of weight of air for each unit of carbon, and 36 for each unit of hydrogen, deducting $4\frac{1}{2}$ for each unit of oxygen in the compound; or in symbols,

$$A = 12\,C + 36\,H - 4\tfrac{1}{2}\,O.$$

In an actual furnace it is seldom sufficient to supply just the quantity of air that contains the oxygen required for complete combustion. It is in general necessary to supply a surplus of air in order to dilute and sweep away the *burnt gas*, as we may call it, and to ensure that every particle of fuel shall have air brought in contact with it. In furnaces with a draught produced by a chimney in the common way, the practical result is, that we have to double the quantity of air, or nearly so. But when we produce a draught by a blast pipe, by steam jets, by a fan, or by other means, which thoroughly mix the air with the gaseous fuel, we reduce the surplus air required very much. In some cases we need only half; in some cases we need no surplus at all. Hence the quantity of air actually supplied, ranges from once to twice the quantity necessary for the oxidation of the fuel.

Here follows a table of examples of the total evaporative powers

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of some kinds of fuel, as calculated from their chemical composition :—

	C.	H.	O.	A.	E.	Evap. due to C.	Evap. due to H.—O
Charcoal.....	·93	0	0	11·5	14·0	14·0	0
Coke	·88	0	0	10·6	13·2	13·2	0
C_{18} H_{20}	·84	·16	0	15·75	22·7	12.7	10·0
C_{28} H_{32}	·85	·15	0	15·65	22·5	12·66	9·84
Coal	·87	·05	·04	12·1	15·9	13·05	2·85
,, ...	·85	·05	·06	11·7	15·5	12·75	2·75
,, ...	·75	·05	·05	10·6	14·1	11·25	2·85
Peat, dry	·56	·06	·31	7·7	10·0	8·5	1·5
Wood, dry ..	·50	·05	·40	6·0	7·5	7·5	0

The first line refers to charcoal; the second to coke of average quality; the third and fourth lines give two examples of hydrocarbons, which comprise between them the chief ingredients of rock-oil. In the third, fourth, and fifth columns are stated the proportions of the chemical constituents, ranging, for the rock oils, between 84 per cent. of carbon to 16 of hydrogen, and 85 per cent. of carbon to 15 of hydrogen. The fifth column gives the net weights of air required for the oxidation of the fuel. In the sixth column the theoretical evaporative powers are set down: for rock-oils they are from 22·7 to 22·5, or, in round numbers, we may say 22½. In two additional columns are some figures to show how much evaporation is due to carbon and how much to hydrogen. In rock-oils, those quantities are 12½ due to the carbon, and 10 to the hydrogen, out of the 22½ units of evaporation. Lines 5, 6, and 7 give a few examples of coal. These might be immensely multiplied; but I have given only three specimens. They differ from the kinds of fuel previously mentioned, in having some oxygen in them, which somewhat lessens the evaporative power. Here, too, the units of evaporation due to carbon and to hydrogen are distinguished; for example, line 6 shows 12¾ units of evaporation due to carbon, and 2¾ due to hydrogen. Then follow some results for peat and for wood, on which I need not enlarge.

It is to be observed that the examples given in this table, which are only a few selections out of much more voluminous data, are all taken from good specimens. In fact, it is impossible to found experiments upon bad specimens of fuel, because people do not send bad specimens of fuel to be experimented upon. But it may be taken as the result of practical experience that the evaporative power of bad specimens of fuel from a particular district is about two-thirds that of good. This applies particularly to coal. The difference is chiefly due to refuse or ash. But it does not apply to mineral oils, because they can hardly contain anything else but combustible matter. They do not contain ash; they do not contain earthy matter. The statement then, about qualities of fuel which have only two-thirds of the total evaporative power of those set down in the table, applies to coal and peat; but it does not apply to mineral oils.

I have gone at some length into the principles of the total evaporative power of different sorts of fuel, because it is of great practical

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importance to understand them. They show the theoretical limit towards which practice approaches in the course of improvement, but which practice cannot surpass nor even attain; the knowledge of those principles prevents people, on the one hand, from forming too small an estimate of the results which may be got from the economical use of fuel; and on the other hand from indulging in exaggerated estimates of those results. It shows us, indeed, what is the actual waste, when we know the result attained in practice; it enables us to judge how far that result falls short of theoretical perfection, and what room there is for further economy by means of improvements.

Now, as to the causes which make the available evaporative power fall short of the total evaporative power.

In the first place, there is imperfect combustion, all the combustible constituents not being combined with the proper quantity of oxygen. This generally arises either from want of a sufficient quantity of air, or from want of a free mixture of air; and in the case of gaseous fuel it sometimes arises from sudden cooling, through coming in contact with some cold substance, so as to lower the temperature and extinguish the flame before the combustion is complete. As to the want of a sufficient quantity of air, the remedy is obvious enough. It is to take care that there are openings enough to admit a proper quantity of air. Still we may supply a very large quantity of air, yet fail to realise complete combustion, because of the air not being thoroughly mixed with the fuel. I have already referred to what we have to do when we have a draught produced, in a quiet way, so to speak, by the ordinary action of a chimney. There is not sufficient agitation of the air to produce a thorough mixture, unless we introduce a surplus quantity of air. We may produce forcibly a thorough mixture of air with the gaseous fuel by such means as the use of the blast pipe, the steam jet, or the fan. This is one of the chief uses of the blast pipe in locomotive engines. The object of blowing steam jets into the furnace, or, at all events, one of those objects, is to produce the same effect. Although the fuel should be solid coke, a great deal of it is actually burned in the gaseous state; for it first undergoes that sort of half combustion that produces carbonic oxide. That carbonic oxide is a gaseous fuel; and in order to burn it completely we have to make sure that it is thoroughly mixed with air. Then, the complete combustion of fuel that is in the liquid state may be promoted by contrivances that blow it into spray, or convert it into vapour, and in that condition mix it with the air. We may blow it into spray by the impulse of a jet of steam; or by superheating that steam we may at the same time convert the liquid fuel into vapour, and mix that vapour with air.

As to the extinction of the flame by cooling, that is a thing which often takes place in steam-boilers, heated by coal that contains a large proportion of volatile constituents. When first set free and brought in contact with the air, these take fire; but the flame comes in contact with the heating surface of the boiler, which is at a comparatively low temperature; the combustion is checked, and instead of combustion, we have decomposition of the hydrocarbon gas. The carbon and hydrogen

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are separated—the carbon in the shape of black particles, which form smoke; and both the carbon and the hydrogen go off to a great extent unburnt.

I might here enter into a calculation to show what amount of waste of fuel may arise from an imperfect or ill-managed supply of air. It would perhaps occupy too much time to go into detail; but I may refer to a fact which I have already stated in the case of carbon, that if it combines with only half of the quantity of oxygen that it requires for complete combustion, we have only $4\frac{1}{2}$ units of evaporation, instead of 15. The evaporative power is reduced to three-tenths, so that seven-tenths of it are lost.

Then in the case of fuel like bituminous coal, which consists partly of solid carbon, and partly of volatile compounds of carbon and hydrogen, we may have the hydrogen going off imperfectly consumed, either alone, or carrying away more or less unconsumed carbon along with it. From what I have stated respecting how much of the evaporative power of the bituminous coals depends on the carbon, and how much on the hydrogen, it will be understood how much may be lost in different cases: $2\frac{3}{4}$, or in some cases 3 units of evaporation if the hydrogen alone goes off without being consumed; and if it carries off a certain amount of carbon along with it, that waste may be more than doubled.

I have spoken of the remedies for the imperfect combustion of gaseous fuel, by thoroughly mixing it with the air, either by a blast pipe or by a steam jet. As to the thorough combustion of carbon in the solid state, one way to ensure that is, by keeping a thin fire, that is to say, having a very large grate in proportion to the quantity of coal to be burned, and burning only a small quantity of coal, say 10 lb. per hour, on a square foot of grate. I have known as little as 4 lb. per hour burned on a square foot of grate. Thus we may ensure that there shall be free access of air to all the burning carbon. But another plan is, to let the combustion on the grate be imperfect, by keeping a thick layer of coal on the grate, which turns into coke, and then to introduce a supply of air above the level of the fuel on the grate, for the purpose of consuming the carbonic oxide and the hydro-carbon gas that are in the gaseous state. There is a known contrivance, called the "dead plate." It is a cast-iron plate at the mouth of the furnace, on which the fresh coal is laid and exposed to a heat sufficient to distil away the volatile constituents. The coal gas so distilled passes over the layer of red-hot coke on the grate: a surplus of air passes through the red-hot coke, sufficient to burn the coal gas. Then, after the coal gas has been all distilled away and burned in that manner, the coke that remains on the dead plate is pushed on to the grate, to be burned in its turn.

In the case, then, of burning coal which is a compound of fixed carbon and volatile hydrocarbon, we have the two plans, of a large grate and a thin bed of fuel, where we have plenty of space; or, of a comparatively small grate and a thick bed of fuel, and introducing air above the fuel to burn the gas, where the space is limited.

There are numerous contrivances for the efficient combustion of coal

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which cannot now be described in detail, such as the use of a separate combustion-chamber of brick, in which the burning of the whole constituents of the fuel, solid and gaseous, is completed, the chamber being built with double walls of brick, and a double arch of brick over the top, so as to prevent loss by conduction. Another plan is to make what we may call "crude gas," by the imperfect combustion of coal, so as to turn all the combustible constituents into a mixture of coal gas and carbonic oxide, and then to burn that mixed gas. There are also double furnaces, air-valves of various kinds and in various places, and an endless series of other inventions.

So much, then, as to the waste of heat through imperfect combustion, and the means of preventing it.

There is another sort of waste of heat: that is, by conduction and radiation. It was ascertained by Péclet, that about half the heat that comes from coal in a furnace radiates directly from the incandescent fuel, and is not carried by the current of flame, or the hot gas, to distant parts of the heating surface. We must be careful that none of that heat escapes from the furnace. For example, if there are openings in the furnace door to admit air, we must take care that the door at all events is double, with the openings of the inner plate not directly opposite those of the outer plate, so that radiation shall not take place through them. Or, we may have a grating of several plates placed edgewise close together, between which the entering air may pass, and so absorb the heat that has been radiated to those plates. I have already referred to fire brick casings round a combustion chamber to prevent loss by conduction. The prevention of that sort of loss is a very obvious matter.

I now come to a third mode of waste of heat, which is a highly important one: that is, the waste of heat up the chimney. The products of combustion escape by the chimney at a temperature above that of the external air. Whatsoever heat is expended in raising the temperature of those escaping gases above the temperature of the external air, is a total loss as regards evaporative power. It is useful for certain purposes. It is useful to rarefy the air in the chimney, and to make it lighter than the air outside, and so to cause the draught of the furnace; but it is not useful as regards evaporative power. The quantity of heat wasted in this way depends upon the specific heat of the burnt gas, which is about one-fourth of that of water; so that for every pound of gas that goes up the chimney, and for every degree of elevation of the temperature of that pound, we have one-fourth of an ordinary unit of heat expended: being in round numbers and for Fahrenheit's scale, about the $\frac{1}{4000}$th part of an unit of evaporation per degree and per pound of burnt gas.

The following formula expresses in a condensed form the waste of heat up the chimney in units of evaporation:—

$$\text{Loss by Chimney} = \frac{1 + A'}{4000}. \text{ Tc Fahr};$$

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and the following are examples:—

1 + A'	13	19	25
Tc	600	600	600
Vol. gas, cubic feet ..	325	475	625
Loss of evap. power .	1·95	2·85	3·75

1 + A' denotes the weight of burnt gas per unit of weight of fuel, and Tc the elevation of the temperature of the chimney, in degrees of Fahrenheit, above that of the external air.

The products of combustion, for the reasons I have already stated, are more or less diluted with additional air; so that in the case of ordinary bituminous coal, 1 + A' ranges from 13 to 25, and 19 is an intermediate value. In the case of hydrocarbon oils, the air that is required for oxidation is about 15·3. We have to add the weight of fuel, and we shall get about 16·3 for the net weight of burnt gas; and it is quite possible that in a well-contrived furnace, no surplus air may be necessary. We multiply the weight of burnt gas which goes up the chimney by the elevation of temperature in the chimney, and if that temperature is expressed in degrees of Fahrenheit, we divide by 4,000, and the quotient is the evaporative power lost up the chimney.

It is easy to see that in order to diminish that sort of loss, we must in the first place have the temperature of the chimney no higher than is absolutely necessary. When the chimney is the means of producing draught, it can be demonstrated that the most effective draught is produced by a temperature not much above 600° Fahr.

It is still more important to avoid an unnecessarily large supply of air to the fuel. We must supply the quantity of air that will give the oxygen necessary to consume the combustible elements, otherwise we shall have enormous loss from imperfect combustion. Every additional pound of air we supply carries to waste a certain amount of heat. I have said that when we produce the draught by means of the rarefaction of the air in the chimney alone, we require 12 lb. of air per lb. of fuel for oxidation, and 12 lb. more for dilution, making altogether double the net quantity of air. If we use the blast pipe as in a locomotive, I think it is quite certain that it is not necessary to supply more than once and a half the net quantity of air, and in some cases we need only supply a mere fraction more than the net quantity. I have very little doubt that in methods of burning mineral oils which I have seen tried, where by the help of a jet of superheated steam, the fuel is thoroughly mixed with the air immediately before the process of combustion, the net quantity of air is sufficient of itself, and we may altogether avoid that very great waste of heat which arises from the supply of an additional quantity of air.

To exemplify the waste of evaporative power that may so arise, I have annexed a few calculations to the formula. I have taken the weight of the gas going up the chimney as first 13 times, then 19 times, then 25 times the weight of the fuel burnt. I have taken the temperature of the chimney as 600° in each case, that being the best temperature when we use chimney draught. In the next line are stated the volumes of gas that go up the chimney in cubic feet per pound of fuel. That,

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however, is a collateral matter. In the next line is stated the loss of evaporative power due to the escape of that gas. And observe that it is in very favourable circumstances. The temperature of the chimney is no higher than is necessary to produce the best draught, yet in the first column the loss of evaporative power is 1·95 ; in the second, 2·85 ; and in the third it is 3·75. Losses much exceeding those are very common.

If the draught is produced by artificial means, such as a steam jet, we do not need rarefaction of the air in the chimney in order to produce a draught. We may have the rarefaction as an auxiliary, but it is not indispensably necessary. In fact, it seems that if we adopt proper means for producing draught by mechanical appliances, we may use such a heating surface as to take up almost all the heat of combustion, and reduce the loss of heat by the chimney to an inappreciable quantity.

I will now say something regarding the results deduced from a comparison of experiments by many authorities upon the effect of extent of heating surface upon the economy of heat. It is through the heating surface that heat is communicated from the flame and hot gases to the water in the boiler. Upon the extent of the surface depends very much the proportion of that heat which is made available. It is not yet possible to lay down any precise theory upon this subject. But the formula I have written down gives, at all events, a good rough approximation to the results of experiment and of practice in a variety of different cases :—

$$\frac{E'}{E} = \frac{bS}{S + aF}$$

Values of	a		·5	·3, &c.
„	b	1·0	·93	·9, &c.

It is based upon principles of this kind,—that whatsoever parts of the heating surface are nearer to the fire, take proportionally the greater shares of the heat, and that each additional area more and more distant from the fire takes proportionally less and less heat. Suppose a certain area of heating surface in immediate contact with the furnace: it will absorb a certain quantity of heat. Then, the next area of equal extent beyond that will absorb a much less quantity of heat; and so on, each successive additional area absorbing a less and less quantity until at length it becomes no longer practically advantageous to increase the area of the heating surface.

By comparison of a good many experiments and a good many results of practical experience, we have this approximation to the proportions of the available to the total evaporative power of fuel, as depending upon heating surface. Let S denote the number of square feet area of heating surface, and let F denote the number of pounds of fuel burned per hour; let a and b be co-efficients to be deduced from experience. We multiply the area of heating surface by the co-efficient b, and we divide by the area of heating surface, plus the number of pounds of fuel burned per hour, multiplied by another co-efficient a.

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From the practical results to which I have referred, it would seem that the value of the co-efficient a, upon which the waste of heat mainly depends, ranges between 0·5 and 0·3. It is 0·5 for a chimney draught, and it is 0·3 for the draught produced by a blast pipe or jet of steam. This 0·3 is found as the result of the use of the blast pipe in locomotives. And it would seem that the co-efficient a is very nearly proportional to the square of the ratio of the total weight of burnt gas to the weight of fuel; so that if we double the quantity of burnt gas, per pound of fuel, we shall quadruple this co-efficient a; if we can reduce the quantity of gas, per pound of fuel, to one-half, we shall reduce the co-efficient a to one-fourth. As to the value of b, it comes very near to unity in some cases, in which care has been taken to make the motion of the water in the boiler take place in the most advantageous direction, relatively to the motion of the products of combustion, that is to say, in the reverse direction—to introduce the feed water in contact with the coolest part of the heating surface, and let it advance gradually to the hottest part, where it is finally converted into steam. That principle was carefully attended to in the boiler invented by Lord Dundonald. If that precaution is neglected, we may lose from 8 per cent. to 10 per cent. of efficiency. But the diminution of efficiency depends mainly upon the waste of heat up the chimney, which is brought into the formula and provided for by the co-efficient marked a.

Here is an example of a particular case:—

$$\text{Let } \frac{S}{F} = 1;\ a = \cdot 5;\ b = \cdot 9;\ \text{then } \frac{E'}{E} = \cdot 6.$$

We will suppose that we have one foot of heating surface for each pound of fuel burned per hour: then S divided by F is equal to 1; that we use a well managed chimney draught, so as to have a equal to 0·5; that we do not pay particular attention to the place where we introduce the feed water, and do not use a feed water heater; so that we get b equal to 0·9. Then, by introducing those values into the formula we get for the efficiency, or proportion of the total evaporative power to the available evaporative power, 0·6. This is a very common case in practice, and when it is realized it is considered a very good result. If we have a specimen of coal whose total or theoretical evaporative power is 15, and we get 6 per cent. of that, and its actual or available evaporative power is 9, that is regarded as a good performance. You see how that arises,—how step by step such a result is arrived at upon scientific principles.

I may observe that the actual efficiency of furnaces—the proportions of the available to the total evaporative power of fuel, go through a very wide range. We find cases in which there is only 45 or 50 per cent. of the total evaporative power actually realized, or made available, and yet these are not considered very bad. From 55 to 60 per cent. are ordinary results, in good marine boilers. When we get above those we get to results that are rather uncommon, and when we get to 80 or 90 per cent. being realized, it is considered very extraordinary.

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In conclusion, I may make the following observations on what we may look forward to as the probable result of the introduction of such classes of fuel as mineral oil as substitutes for coal. Coal is a very complex kind of fuel. To ensure the best possible economy in the use of it requires the fulfilment of many different conditions, some of which conflict with each other. We have to burn fixed carbon, and we have to burn the gas that is disengaged from the coal. We may burn one very efficiently, and not burn the other. It is extremely difficult to manage the introduction of air, so that there shall at once be no risk of a deficiency of air, which causes imperfect combustion, and gives bad economy in one way; or a surplus of air, which carries heat to waste up the chimney, and causes bad economy in another way. On the one hand we are exposed to the risk, from any little fault of construction or management of the furnaces, of the hydrogen going off unburned, and of its carrying off a large portion of the carbon unburned also. On the other hand we are exposed to the risk of solid carbon being imperfectly burned, and going off as carbonic oxide. The contrivances for diminishing the causes of waste are somewhat difficult and complex to apply in practice; and above all, too much depends upon the skill of the fireman or stoker. We may say almost everything depends upon the way the furnace is managed. The very best furnaces, the very best boilers that were ever contrived, may be made extremely wasteful by a careless stoker. On the other hand, in using mineral oils, we are somewhat in the position of the chemist who has got a good burner for burning coal gas. We have to contrive a suitable apparatus for introducing that oil into the furnace in such a way that it shall be thoroughly mixed with air—whether in the state of vapour, or in the state of fine spray, with or without the assistance of some porous substance to act as a wick. A steam jet seems to be the most efficient apparatus for that purpose. Then if our apparatus is properly contrived and properly constructed, and works in the right manner and produces complete combustion at first, there is no reason to suppose that it will ever act badly if treated with ordinary care.

It would seem to be no difficult matter with fuel of that sort to diminish the waste of heat through imperfect combustion to nothing, and the waste of heat through hot gases going up the chimney to something very small indeed. In fact, such an efficiency as 90 per cent. of the total evaporative power being realised, instead of being a very extraordinary thing, may be looked for as a very ordinary thing; so that, taking the theoretical evaporative power of some hydrocarbon compounds at 22½, we ought not to be surprised that even with rude apparatus, in a merely experimental state, we get an evaporation of 19 or 20 times the weight of the fuel—say 19, at all events. I believe that has been realised in experiments that have been made, and that are now being continued.

There is another phenomenon as to which I may say something—the mode of operation of steam jets in cases of this kind. There can be no doubt that one use of the steam jet is the mechanical action to which I have frequently referred—the thorough mixing of the gaseous

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fuel with the oxygen required for the purpose of combustion—the churning of the particles all together, so that they shall be brought thoroughly into contact. There may be another mode of operation of steam—a chemical action whose effect is to prevent the deposition of unconsumed carbon from gaseous fuel. All hydrocarbons have a tendency when raised to a high temperature to deposit the carbon, unless it be instantly burned. We see that in the smoke that a flame tends to give out, if there is anything to prevent immediate and free access of oxygen to the carbon. Now it is possible that besides its mechanical action, the steam jet may also have a chemical action of the following kind:—The oxygen of the steam combines with the carbon of the hydrocarbon fuel, and the hydrogen of both is set free; there is a mixture thus produced of carbonic oxide and of hydrogen, which is sure to be completely burnt as soon as a sufficient quantity of air gets access to it, and thus the deposit of unconsumed carbon is entirely prevented.

I have now gone as far as I think I can venture to occupy the time of this meeting. It would be out of place for me to enter upon the consideration of nautical questions, such as the comparative weight and bulk of different sorts of fuel; therefore I have now only to thank you for the kind attention with which I have been heard.

The CHAIRMAN: Does any gentleman wish to make any remarks upon the paper?

Captain JASPER SELWYN, R.N.: This is a subject which has engaged my attention for the past two years. I had the pleasure of bringing it to the notice of this Institution, persuaded as I was of the enormous value of the whole question, more particularly to the Navy of this country. I knew that if the economy which Professor Rankine has put before us, and the use of materials better adapted for such combustion as we require, were once brought into play, that a very great proportion of the unjust fears, which existed two years ago very strongly indeed, as to the consumption of our whole coal supply, would be met by an economy which was the truest method of supplementing any possible failure; though I scarcely believe such to exist. I am sure that had the members of this Institution been more generally aware, particularly my naval brethren, of the very complete way in which the whole question of the economy of fuel would have been brought before them to-night, we should have seen a very much larger attendance than we now see. However, it matters the less, because this is a paper which will be read with the greatest attention in the Journal. It will, I am persuaded, command a very wide class of readers, not alone in the Navy, but among all those who are interested in this great question; among foreigners as well as our own countrymen. Professor Rankine has followed up, most beautifully, I think, the composition of fuel, the value of each proportionate part of it in accomplishing the effect we desire, the causes of loss, and the possibility of economy. The points to which he has drawn your attention are those which belong to the science which he has cultivated with so much success. The points to which I had the honour of drawing your attention were principally those which affect our own profession, inasmuch as this was a fuel which alone could be burned with greater economy, would require fewer attendants, economising their wages and victuals, would be attended with more certainty even by inexperienced persons, and would give us a power of stowing and taking it on board conveniently in places where we could not have so stowed it formerly, and with none of those wretched residuary products which we find so much difficulty and so much nuisance in getting rid of. The Professor has adverted to the causes of loss in the deposit of carbon. I think I may ask him whether he is not of opinion that that has another and most important effect, which is that the heating surfaces, becoming covered with such a

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deposit, lose very materially their efficiency; and that wherever an entire absence of such deposit can be obtained, it not alone indicates economy of the unconsumed carbon which is now burned, but it indicates also the increased efficiency of the heating surfaces, which are left in their integrity, as the maker intended them to exist. The question also of blasts has been brought very strongly before you, showing you the economy of the artificial blast, and where this blast is supplied, at such a point of the furnace as to be itself a contributor to the total heat of combustion, and in this way it becomes clearly very much more valuable. I think I gathered from what Professor Rankine said, that he considered it quite probable that a double decomposition took place, and that the oxygen and hydrogen of the steam contributed to the total heat of combustion; therefore, although it was necessary for the purpose of the blast to sacrifice a certain portion of the steam generated in the boiler, yet that steam, having done a certain portion of mechanical duty in creating blast, also restored to the boiler a certain proportion of the duty of combustion, and was not, therefore, so great a loss as some persons would be led to believe. I put this more in the shape of a question, which I hope Professor Rankine will remember in his reply, in order that my naval brethren may be thoroughly aware of what the bearings of the question are upon points which are perhaps a little obscure. The question of burning mineral oils is also very materially a question of price. Now, if we were to bring to this Institution a proposition to burn something which cost £10, £15, £20 a ton, you would probably meet the person who brought forward such a proposition by saying, "We are aware that such great results may be obtained by such expensive fuel, but we think the expense too great to be justified." But we do not do that here. The term "mineral oil" is applied to a wide range of products, many of them refuse products, such products as arise from the distillation of illuminating oils, and from the refuse of gas manufactories, which are known by the name of "dead earth oils," and which are sold entirely as refuse at prices not very materially above that of coke. From a halfpenny to three-halfpence a gallon, I think, is the price at which they are being actually burned at this moment, and doing duty rather in excess, I think, of what Professor Rankine has claimed for them as yet; not in excess of the theoretical evaporative power, but in excess of the power which Professor Rankine claims in his last words—the theoretical evaporative power very largely secured with very little waste; and an economy in all other points, such as he has spoken of being pretty fairly carried out in these early experiments, has resulted in the duty, done by 30 lb. or three gallons of this dead earth oil at from one halfpenny to three-halfpence a gallon, being precisely the same as had been previously done in the same boiler, with very little change in it, by 60 lbs. of coal. Now, I hope that this subject will not be allowed to drop; that it will be made the subject of very close study indeed by those who are responsible for the cheap and efficient conduct of our naval affairs. I, for one, have to lament the knowledge which I have recently acquired, viz., that one of our most recently built iron-clads can only carry four days' coal to sea. I say distinctly, and I am sure my naval brethren will say with me, that it is utterly impossible we can go on in that way; that to encounter a great European war with such means of locomotive power, even though we should have carried out the views of seamen, and not of those who advocate fighting machines without masts or sails, although we should have carried into effect good sailing ships as well as good steam-ships; yet if they can only steam four days, we shall lose the empire of the ocean for want of being able to go to sea under steam, or, I should say, to keep at sea under steam. I hope, then, that some other person will kick the ball again; that this will not be a subject with respect to which it will be said, "There has been a splendid paper read upon it; we will now consider the subject as closed." Let us rather consider it as only now opened—most ably opened by Professor Rankine. I am sure he has given those who are inclined to study the subject at all the materials with which they may do so successfully.

Mr. J. RICHARDSON, C.E.: As regards fuel, I think we may safely say that that fuel is the most valuable which can be burned with the least waste. We all know that the best coal when carefully burned will evaporate 10 lbs. of water to 1 lb. of coal. Laboratory practice is hardly a test of the result in real practice. In this, evaporation is seldom obtained of more than 7 lbs. of water to 1 lb. of coal. There

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is a cause which considerably accounts for this difference. It is necessary in large furnaces, every seven or eight hours, to remove the clinkers from the fire bars; and in doing so, the stokers seldom stop at two-thirds of the contents of the grate, but they rake out nearly all the contents, clinkers and ashes, and the whole go over the side into the sea. This is not enough: every three or four hours all the ashes are raked out, and they go over the side. Besides the waste of coal in raking out the fires; there is also deterioration of coal in hot climates. I have had the opportunity, when at Woolwich, of speaking to engineers there, and they all confess that the amount of evaporation obtained from coke and coal in a long voyage is never more than 6 lb. of water to a pound of coal. Liquid hydrocarbon can be burned nearly without any waste. A ship starting from Southampton, and going to Calcutta, has only got to get her steam up before she leaves the harbour. She may have her furnace doors locked, and she may keep them locked till she gets to Calcutta; and there may be an evaporation obtained of 16 lb. to 18 lb. of water from one pound of fuel, without the slightest change, the whole distance. Evaporation can be obtained without the least trouble to the stokers; they have only to attend to the fire, and see that it does not make too much head, or get on too fast. The fact is that 200 lb. of this liquid hydrocarbon will produce as much heat as 600 lb. of coal. I think this is a most important result in favour of these fuels. There is one fuel that has not yet been tried. This is a solid fuel—naphthaline—and I believe is stronger than creosote. I believe it would produce 24 lb. of evaporation. The Admiralty have given a common service boiler, which is going to be tried, first with coal, and then with the liquid hydrocarbon fuels.

Captain BURGESS: What is the price of the naphthaline?

Mr. RICHARDSON: About 18*s.* a ton.

The CHAIRMAN: What effect has oxygen when chemically combined with fuel?

Professor RANKINE: With respect to the question you have just put, we know from the results of experiment, when oxygen does exist in a state of chemical combination with fuel, that it actually forms water with part of the hydrogen. Its operation is this: it annuls the heating effect of a certain portion of the hydrogen. Suppose in 100 lb. of a certain sort of fuel there are, we will say, 5 lb. of hydrogen, and 4 lb. of oxygen, those 4 lb. of oxygen render ½ lb. of hydrogen inoperative. It does not burn, because it has combined with the oxygen, and it cannot combine with any more. So, while the total hydrogen in the fuel forms 5 per cent. of its weight, the effective hydrogen is only 4½, the remaining portion being rendered inoperative, owing to the presence of the oxygen with which it is able to combine. That seems to be the explanation of the effect of the presence of oxygen in coal. It is well known that it deteriorates the coal. It is further certain that this is one of the causes why coal exposed to the atmosphere becomes deteriorated, and loses heating power. It is equivalent to a partial combustion, leaving so much the less to be burned. Then, with regard to the previous remarks, there is no doubt that all that has been said about the stirring of the fire to remove the clinkers is perfectly sound and perfectly applicable. It is a cause of great waste of heat; and it is important, as regards one objection to the use of coal to which I have already referred, that it leaves so much dependent upon the skill and care of the stoker. There is no doubt that, with very careful firing, the waste from this cause may be reduced perhaps to only about 2½ per cent. of the total evaporative power; but with bad and careless firing, there is no saying how much it may amount to. With mineral oils you are free from dependence upon uncertain matters of that sort. Captain Selwyn put a question regarding the chemical action of a steam jet. There can be no question at all about the advantage of its mechanical action, mixing the air and the fuel together, and bringing the oxygen into thorough contact with the inflammable matter. As to chemical action, as far as chemical action upon steam itself is concerned, it would just amount to this—that the steam is first decomposed into oxygen and hydrogen; and that then the hydrogen is combined with the oxygen again. The result of that, as regards heating power, would be simply nothing. A certain quantity of heat disappears in decomposing water; precisely the same quantity of heat is reproduced by the oxygen combining with the hydrogen again. It is indirectly conducive to a very important saving: all that oxygen which is separated from the

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hydrogen during the decomposition of the steam serving to hold in solution the carbon of the inflammable gas or oil, and to prevent its being deposited in a solid form. I quite agree with Captain Selwyn. It was an omission on my part not to refer to the prejudicial effect of such a deposit of carbon upon the heating surface, in reducing its conducting power. It is no doubt from a cause like that—from the carbon encrusting the heating surface that cases of this sort have arisen: —a steamer would make her trial trip burning only 4 lb. of coal, per indicated horse-power, per hour. She would start upon her voyage burning the same quantity. The consumption would gradually rise to 4½ lb., 5 lb., and so on, and at the end of the trip she would be burning 6 lb. of coal, per indicated horse-power, per hour, without any deterioration in the working or in the management of her engines, but solely from the loss of conducting power, owing to the deposition of the carbon upon the surface of the tubes.

Captain SELWYN: May I say that I particularly wish to have an opinion from you with regard to the difference between the action, chemically and mechanically, of the blast in the chimney and the blast in front of the furnace?

Professor RANKINE: I think there is one difference with respect to the mechanical action—that a blast directly into the furnace is much more efficient. It produces a more thorough mixture of the inflammable gases with air than the chimney blast does. A chimney blast in a locomotive is a very convenient thing; but I do believe that you can produce an equally thorough mixture, or a more thorough mixture by direct blast into the furnace with less expenditure of air. Then, as to the indirect chemical process to which reference has already been made. Of course, if you blow steam into the chimney it does not take place at all. That chemical process that tends in an indirect way to economy of fuel can only take place if you introduce steam in contact with the inflammable gases. I am glad that Captain Selwyn has referred to this matter, because I ought to say something as to the temperature at which steam is introduced. Captain Selwyn has referred to this fact, that it may be said a certain quantity of heat is wasted in generating this steam, but that heat is made available again. Now, that depends, I may say, almost entirely upon the temperature at which the steam is used. You expend a certain quantity of heat in evaporating water, and you send the steam in at a comparatively low temperature. In the ordinary state of saturated steam, the temperature of that, as compared with burning fuel, is cold. It may be very hot as compared with the ordinary temperature of the atmosphere; but as compared with the temperature of fuel in the furnace, it is a very low temperature indeed. A body cannot give out heat to a body that is hotter than itself, so that the heat spent in producing steam at a comparatively low temperature will be wasted; but if you use superheated steam, in the first place a much less quantity of steam will serve the purpose. The mechanical effect depends upon pressure and volume. In order to get a great pressure and a great volume with small weight of material you must employ a high temperature; you must, in short, use superheated steam. As a great part of the expenditure of heat in producing the steam depends on its weight, the use of superheated steam tends to lessen the expenditure of heat for a given mechanical effect. Then, if you raise the steam to a temperature approximating to that of the flame itself, you get back nearly the whole of the heat again; because the superheated steam, being at a higher temperature than the heating surface of the boiler, gives out a great part of its heat to that surface just as the flame does.

The CHAIRMAN: I am sure that the meeting will join with me in offering our thanks to Professor Rankine for this lecture—I may say for this lesson. As an old Naval Officer myself, I feel that during the time when I was captain of a line-of-battle ship I should have been very glad of such a lesson as we have had to-night. I may also add that I hope it will be of great use, not only to us who are going out of the profession, but to those who are rising up in it. I must also make another remark—that the small number who are here present is no measure of the value of a lecture such as this, or of the good that it will effect. There are many others who, thanks to our Journal, will have the opportunity of studying this lesson, Naval Officers especially. There is a great deal in the professional part of the question which Professor Rankine

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has thought it right to leave out. But points have been touched upon very ably by Captain Selwyn in almost every one of which I cordially join, because I think those points are of great importance. The efficiency of our Navy will very much depend upon the fuel we shall use in the future, and upon the way in which we shall be able to economise the use of it, or economise the space for it in stowage. Every pound of fuel we shall be able to save hereafter will be so much space gained; not merely space gained for air and so on, but space for efficiency, for the life of the ship, because her efficiency depends upon the quantity of fuel she can stow. She is no man-of-war if she goes to sea devoid of fuel, and is met by an enemy with a good supply. There would be an end of her. We must also remember that all we can gain in the way of space and efficiency will enable us to carry a better armament, and to devote the space saved to other purposes, even if we do not devote it to the life of the ship, viz., the fuel she carries; for fuel to a ship is as the air we breathe. I must again ask you to join with me in thanking the Professor for the very able lecture which he has given us.

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Evening Meeting.

Monday, June 3rd, 1867.

MAJOR-GENERAL J. T. BOILEAU, R.E., F.R.S., in the Chair.

NAMES of MEMBERS who joined the Institution between the 20th May and the 3rd June, 1867.

ANNUAL.

Rochfort, Charles G., Capt. 20th Regt., £1.
Winthrop, Hay, E.S., Capt. R.N.

FURTHER PARTICULARS REGARDING MONCRIEFF'S PROTECTED BARBETTE SYSTEM.

By Captain A. MONCRIEFF, Edinburgh Artillery Militia.

Since I had the honour of first introducing this subject here on 3rd June, 1866, I have not made so much progress with my invention as I could have wished, but such progress as my own means have enabled me to make has been of a satisfactory kind, and it affords me much pleasure to have this opportunity of reporting the results.

As probably the best way of re-introducing the subject, I shall briefly sketch the history of the invention up to this time, defining it in as few words as I can.

The invention consists in mounting guns in such a manner that the act of firing makes the gun descend below the parapet, where it is secure from direct fire, and where it can be loaded and traversed by the gun detachment, without their being exposed. The force of the recoil, which drives the gun back and takes it down under cover at the same time, raises a counterpoise, and the spare energy of the recoil is stored in raising the counterpoise, and on the gun being released from the loading position, this spare energy brings it up into the firing position without labour. The counterpoise, moreover, is attached in such a way that the shock of the discharge is gradually conveyed to it (this

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being a most important condition where such large weights have to be put in motion). There is also interposed between the gun and counterpoise, a moving fulcrum, which has the effect of taking off horizontal strain from the platform. In this, and the system of defence based on it (where all the guns have free sweep, and can be mounted in gun-pits or in batteries without a visible parapet, or below water level), consists my invention.

The idea first occurred to me in 1855. I was impressed with the advantages that would be gained by dispensing with embrasures, even with the old ordnance, while watching on the spot the operations before Sebastopol. This impression led me to try to invent some simple means of raising the guns for firing, and lowering them under cover for loading.

It is difficult now for me to describe the path by which I arrived at my present conclusions, but that path was paved with many plans for arriving at the result now so simply obtained. I brought into requisition every mechanical appliance I could think of, that appeared suitable, and a good many pretty designs were the result; but simplicity was not their general characteristic. At last I conceived the idea of interposing a moving fulcrum between the gun and a corresponding counterpoise, which is now the principal characteristic of my invention.

I submitted my first plan based on this principle, in 1858, to General Sir R. Dacres, under whose command I happened to be at the time, who thought it of sufficient importance to bring it under the notice of the Secretary of State for War.

It is probably better that I should not now go into all the hopes and disappointments I have had since in attempting to bring it forward, but I shall pass on to the time when I read my paper here last year.

I was much encouraged to persevere, by the reception I met with from this Institution, and shortly after reading my last paper, I submitted the invention once more to the Government—I am sorry to say, with no better success than formerly. I had now three courses left open for me—to let the matter drop—to take it out of England—or to conduct an experiment with a full-sized gun at my own expense, in order if possible to remove the scruples which Government had shewn to incur the expense of trying my plan. I chose the last course. General Peel was good enough to supply me with an iron 32-pounder, which I mounted in the neighbourhood of Edinburgh on my principle. In order to save expense, I was careful that the principle only should be thoroughly tried in my carriage, but did not attempt to make it a pattern for the Service; it was simply an experimental carriage, and its defects were such as to make successful action more unlikely, and therefore, at the same time, more conspicuous. Those members of this Institution who had faith in the soundness of my principle, when it had only been tried with a working model, will share my gratification at the results of this experiment. Not only did the carriage stop the recoil without strain, but it did so with a smoothness and an absence of vibration that at once satisfied those who saw it, that as a mere mechanical appliance it had good working qualities. But to those who looked a little farther and were aware of the destructive effects caused by vibration and the enormous horizontal strain on the platform in

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firing modern heavy artillery, the experiment suggested the possibility that my system might not only answer for the largest class of ordnance, but might, in addition to its other advantages, remove the difficulty now felt of providing sufficient foundations for batteries and traversing platforms strong enough for the largest guns.

The following is the memorandum of experiment conducted at Edinburgh:—

Memorandum of Experiment.

Edinburgh, 3rd December, 1866.

"In 1865, a model to illustrate this invention was constructed. It represented a 95-cwt. gun on ¼th scale. This model was experimented upon in presence of Colonel Dickson, C.B., V.C., then commanding the Artillery in Scotland, and the officers of that arm of the service stationed at Leith.

The result, as far as could be obtained by the model, was most satisfatory; but it is well known that model experiments are not always conclusive, and to remove doubts as to the principle on which the invention is founded, the present experiment is about to be tried.

To avoid expense, the mounting of the gun to be now tried, is of the rudest description, compatible with a full and clear illustration of the principle; and it is evident that such rudeness is against the invention, and not in the inventor's favour.

The gun is a 32-pr., on its own carriage. The elevators are a pair of locomotive driving wheels, of 7 feet diameter, fitted up for the purpose, and mounted on two ordinary rails secured upon sleepers, to represent the platform. Two axles near the circumference of the wheels connect them together, from one of which the counterweight is suspended, and on the other rests a timber frame, on which the gun on its carriage is secured.

The gun, its carriage, and the frame, represent a weight of about 68 cwt., and the counterpoise is about 78 cwt., giving a preponderance to the weight of about 10 cwt.

The points to which the inventor would solicit special attention are as follows:"—

1st Shot.

Details.	Remarks.
Charge 8 lbs. powder and 32 lbs. shot.	Filled in by Col. Burgman, R.E.
1. Distance the wheels travelled on the rails.	3 feet 3 inches.
2. Recoil smooth and steady, or accompanied with vibration,	Smooth and steady.
3. Recoil gradually checked, and the gun brought to a stand without jar or jerk.	Quite so.
4. Whether or not any vibration that would injure slight masonry works, is transferred to the platform.	No visible sign of vibration in the platform.

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2ND SHOT.

Details.	Remarks.
Charge, 8 lbs. powder and two 32 lbs. shot.	
1. Distance the wheels travelled.	5 feet 3 inches.
2. Recoil smooth and steady, or accompanied with vibration.	Recoil smooth and steady, without vibration.
3. Recoil gradually checked, and the gun brought to a stand without jar or or jerk, or the contrary.	Recoil gradually checked, but it was sufficient for the whole length of the rack to pass over the paul, and when the gun began to run up by the action of the counterpoise, the paul jumped twice before it caught. The rack and paul were rudely made, and were quite a temporary arrangement.
4. Whether or not any vibration that would injure slight masonry works is transferred to the platform.	None.

(Signed) G. H. BURGMAN
Com. R.E. in N.B.

"I witnessed the above experiments, and agree in the remarks made by Colonel Burgman, R.E., as to the results of each shot.

(Signed) "FRED. WM. HAMILTON,
"Maj.-Gen. Commanding.

(Signed) "J. R. ANDERSON,
"Col. Commanding the
"R.A. in N.B."

On the 28th November, 1866, I wrote to the Right Hon. the Secretary of State for War, informing him that I had completed my experimental carriage, and would be glad to know if he would appoint any one to report on its performance, or to subject it to any tests that might be required.

On the 12th December, I received an intimation that an Officer of the Ordnance Select Committee had been directed to proceed to Edinburgh to test my carriage. On the 14th December, Colonel Wray, C.B., of the Ordnance Select Committee, arrived.

I shall quote a portion of the report he made to the Ordnance Select Committee—that portion which applies to the actual experiments.

"The following rounds were fired:—

Round. No.	Charge. lbs.	Shot. lbs.	Recoil.	
1	8	32	4 ft. 1 in.	cap square of garrison carriage cracked.
2	Repeated		3 ft.	
3	13	0	4 ft.	4° elevation.
4	8	Double shot	5½	
5	Repeated		5	

"Tackle substituted for the rack in the last round, the gun recovered "its position without jerk or strain.

"Nothing could be more perfect than the working of the whole "machine under the above trials; the recoil was smooth, and the gun "being brought to a stand after each round without jar or jerk, and

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"there were no visible signs of vibration in the platform or any part "of the structure.

"The rack and paul did their work perfectly, carrying out to the "letter the principle (as described by Captain Moncrieff) of storing "the energy of the recoil, which, on being released, quietly allowed "the gun to recover its fighting position through the agency of the "counterpoise."

The report then goes on to criticize the application of my system to large guns, and to point out the possible inconvenience of large counterweights and the difficulty of traversing, &c., &c.

The most satisfactory, and perhaps the only way of solving such questions is to put them to the test of trial; and it is only denied by a few, that the issue is of sufficient importance to justify a series of experiments. Those who are best acquainted with the present question of fortification are probably at the same time those who will put the highest value on an invention that will, with simplicity of action, perform the function which mine performs. I have great hopes that Government will still authorize a trial, notwithstanding their last refusal. The necessity for some plan of the kind is so generally allowed, and my design promises so many advantages, especially as applied to coast defence, that it appears wasteful on their part to continue the expensive works required for present appliances, while my system offers any probability of success.

I shall now take the liberty of reading only two letters, one from a civilian, and the other from a soldier. This meeting will understand how to value the testimony of both. I am sure that I could not select two authorities whom I should better prefer to rely on.

(1)

"*From W. MacQuorn Rankine, Esq., Professor of Civil Engineering, &c., &c., University of Glasgow.*

"To HENRY GLASSFORD BELL, Esq., &c., &c.

"59, St. Vincent-street, Glasgow,
"17th April, 1867.

"My Dear Sheriff,

"It would be beyond my province to give any opinion as to the military merits of Captain A. Moncrieff's method of mounting guns; but in a purely mechanical point of view, I can confidently state that I consider it both sound in principle, and likely to answer well in practice.

"I am, yours very truly,
"W. P. MACQUORN RANKINE."

(2)

From Colonel Simmons, C.B., R.E., Director Royal Engineer Establishment, Chatham.

"Royal Engineer Establishment, Chatham,
"18th March, 1867.

"To CAPTAIN MONCRIEFF, &c., &c.

My Dear Sir,

"I have been looking lately with much interest at the description and plans of your proposed system for raising guns, so that they may fire over a parapet, and in their recoil fall down below it, so as to be completely concealed from view. The object, the solution of which you have proposed to yourself, is one of very great

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importance to the service, and one which, before I knew you had turned your attention to it, had occupied mine so much, that I had tried to direct the attention of my brother officers to it, and I also suggested it as a problem requiring solution to some mechanical engineers, thinking it might probably be accomplished in a convenient manner by hydraulic power.

"The importance which I attach to an invention of this nature is very great. By it the gun is effectually concealed when not in action, and is kept under cover for the greater part of the time it is in action. The gun, when placed behind a parapet or epaulment, or in a pit, presents no object upon which an enemy can direct his fire; the importance of this, when opposed to rifled guns (both small and great), cannot be exaggerated, and moreover, it disposes of the difficulties attending the use of embrasures in earthworks, whether for attack or defence. These difficulties are very great:—

"1st. The embrasures present a fixed and constant target upon which guns may be laid.

"2nd. Embrasures weaken a parapet, and, as usually constructed, present the most favourable conditions for bursting shells fired with percussion fuzes, the thin part of the merlon affording just resistance enough to fire the fuze.

"3rd. The gun is always more or less exposed to injury from direct fire.

"4th. No revetment has yet been found for the cheeks of embrasures, which is not readily destroyed, either by the fire of their own guns or those of the enemy, thus shutting the guns up and necessitating repairs, which are among the most dangerous duties of the soldier.

"Various means have been proposed for palliating these evils, such as fixing iron shields, revolving cupolas or towers, and many other schemes which lessen the efficiency of batteries, by restricting their lateral range, and, all of which that I have ever seen, are exceedingly costly, and after all are only a very partial cure for the evils complained of.

"It appears to me that the system of loading guns below the parapet, which may be of earth of any thickness, and therefore very difficult to destroy, and only bringing them up to an exposed position at the moment of firing, gets rid of all these difficulties.

"Of course any system which may be proposed for this purpose must have objections of its own; but I confess that your scheme is more free from objection than any I have seen: and having given it my best attention, I see no reason why it should not succeed with guns of any weight, however great, that are ever likely to be introduced into the service. If successful, it will save an enormous outlay to the country in its fortifications, which, in these economical days, is almost more thought of by those who control expenditure, than efficiency,—at the same time that it will add enormously to their practical value when submitted to their true test by an enemy's fire.

"Your scheme appears to me to present no mechanical difficulties but what might easily be overcome, and it gets rid of one great mechanical difficulty which has not yet, I believe, been solved with guns as now mounted on the most approved pattern of carriage and traversing platform. I allude to the horizontal strain brought by the recoil upon the various parts of the carriage, platforms, racers, and traversing bolts. This action is a very serious difficulty with guns on traversing platforms, whereas, according to your system, there will be little or no tendency to force the turn-table or traversing platform back.

"You may expect objections to be taken to the weight and bulkiness of your counterpoise; but I don't think they need disturb you, as, when once the gun is mounted, this counterpoise actually diminishes the labour of working the gun, forming, as it were, a reservoir of power to run it up; and with regard to its bulk, you may reduce that considerably by the employment of lead, cast in ingots, so as to pack very closely, and still be manageable on the rare occasions when it may be necessary to dismount the guns.

"I see no difficulty whatever in constructing a proper turn-table, for, after all, the weights to be dealt with are not greater than are to be seen daily on turn-tables on railways, and absolutely nothing compared to what may be seen in operation on board ship with cupolas and revolving towers.

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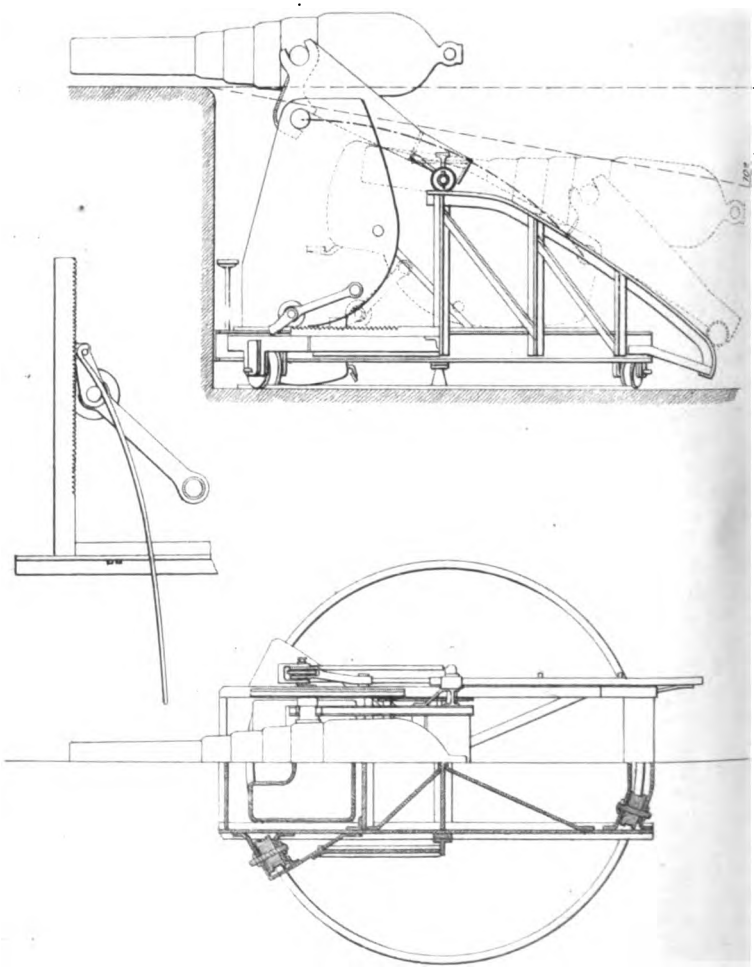
Sketch of Proposed Adaptation of Moncrieff's System (without Details) to a 7 ton Gun.

May, 1867.



Inches: 0 6 1 2 3 4 5 6 7 8 9 10 11 Feet

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"One great objection which may be raised to any system of this nature is, that it is not compatible with the protection of the guns from vertical fire. The question between guns protected in this way and others in casemates is therefore one of the relative danger of horizontal fire at embrasures and vertical fire. For my own part, I should not hesitate to choose in favour of the system as worked out by you, the gun being protected on its flanks and rear by traverses, which would reduce the danger to a minimum.

"There are many situations, however, where casemates are inapplicable, and, when opposed to shipping there is very little danger to be apprehended from vertical fire. In such situations I have no hesitation in saying, that some plan such as this of yours, if it succeed, will be an immense improvement on anything we now have, and will be invaluable. I hope, therefore, you will persist with your system, and get it thoroughly tried.

"Believe me, dear Sir,
"Yours very truly,
"J. L. A. SIMMONS."

Having so far explained the position of my invention, I shall now glance at a few of the adaptations of it that have occupied my attention.

I have endeavoured to apply my principle to an ordinary 40-pr. Armstrong siege-gun, taking its carriage as it now stands, and turning it into a temporary elevator on my principle by the addition of a light traversing platform, two plumer blocks, and two wheel blocks, as shewn in the drawing before you.

I have also applied it to an ordinary 95-cwt. gun in several ways; drawings of some of these are on the table.

I have also applied it to a 7-ton gun, using for elevators two $\frac{1}{4}$th plates, collapsing at the axle on forged blocks of iron, and strengthened and held together by ⊐ iron, securely rivetted to both plates (see plate XV).

The carriage in this case is supported at the rear on two curved rails, which guide it in its descent from the firing to the loading position.

The frame traverses on a racer 12 feet 4 inches in diameter and central pivot.

I have also planned a smaller carriage, where the trunnions themselves play in the elevators, without the intervention of the gun-carriage proper.

Having suggested a few of those forms in which my principle is likely to be applied to ordnance, it is perhaps better not to anticipate the results of next experiments, which will probably be tried by Government.

My own experiments, the reports of which have been laid before you, are sufficient to decide, at any rate, the soundness of the principle, and justify some confidence in the success of what remains to be done, if all details are properly attended to, in the manufacture of the carriages. I shall, therefore, leave that part of the subject, which deals with the carriage itself, and direct your attention to the advantages, at once within reach, when a complete carriage, made on my system, shall be obtained.

I shall classify the characteristics of my system under a few heads,

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under each of which a comparison can be made with other systems, and the balance struck.

1st. Economy of labour in working the gun.
2nd. The power of masking the battery.
3rd. Power of meeting recoil, and removing horizontal strain.
4th. Power of traversing.
5th. Economy obtained in the construction of works independent of the carriage itself.
6th. Comparative protection from vertical fire.
7th. Comparative protection from direct fire.

1*st. Economy of Labour in working the Gun.*

In regard to the first point, viz.:—"Economy of labour," it is well known how much the demand for greater power in our artillery, has increased the weight of the guns. A few years ago a 95-cwt. gun was pointed at as a formidable engine of war, but now, a 7-ton gun is the smallest that is considered worthy of any consideration as a garrison gun—and 7, 9, and 12-ton guns are looked to as the ordinary guns for coast defence—not to speak of the problematical 23-ton gun. Even those who are not acquainted with working guns, can easily imagine the difficulty of dealing with a mass of iron 9 or 12 tons in weight, and the number of men that are required to do so efficiently. To cure this evil, I apply the homœopathic maxim, "*similia similibus curantur*," though not, I confess in homœopathic doses! I employ one elephant to tame another;—to overcome the objection to one great weight, I employ another, and the result is, that the gunner has only to deal with the difference between the two; instead of having to move 12 tons, he has only to regulate the application of energy exerted by the recoil, and the gun, as it were, almost works itself. Thus, the greatest application of power required from the gun detachment is to traverse, and that, as I shall explain under head 3, can be reduced.

The labour of lifting the projectile to the muzzle can also be dispensed with, as my carriage lifts up its own shot to a convenient position for loading; those who have gone through this straining operation, with large projectiles, will appreciate the advantage of having it done so easily.

2*nd. The power of masking the Battery.*

The power of concealing the position of batteries before action, gives an advantage that has made the practice of masking batteries, one that is commonly resorted to. A battery on my system can enjoy this advantage to a greater degree than one in which the guns are in embrasures, or mounted *en barbette*, or in a cupola; because the parapet may be *made* to resemble, or may actually be the natural surface of the ground itself, with nothing on which the eye can rest, nor at which the enemy can aim.

Of course, for the few seconds during which the gun is laid, it

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must be exposed in the same manner as the guns are in *barbette* batteries, but that exposure ceases at the moment of discharge.

I shall here explain more fully than I did in my last paper, an appliance which would probably be invariably used in batteries made on my system. This appliance is a transparent screen, capable of being raised in front of each gun, or removed at pleasure. There are many convenient materials of which this screen could be made, which would vary according to the ground and the circumstances; and if no other material was at hand, small brushwood would do. The effect of using such a screen would be, to give an important advantage to my battery over those opposed to it. As the enemy would no longer be able to see whether my gun was up or down, and the first intimation he would receive of the gun being up would be its fire, after which to run the chance of hitting it when up, he must continue to fire at it all the time it is down; and as the gun when down is absolutely secure from direct fire, the enemy would not only have to overcome the chance of missing the position of the gun, but in addition to that, he must waste his fire in the same proportion that the time during which my gun is down bears to the time it is being laid, which proportion might be increased or decreased by those in my battery at pleasure, by slackening or increasing the fire.

3rd. Power of meeting Recoil and removing Horizontal Strain.

The recoil of guns up to this time has been stopped by applying friction in one form or another, and since the introduction of the new and powerful artillery of the present time, it has been found necessary to increase that friction. The most approved method of so doing is by American compressors, by which almost any strain can be resisted.

This convenient appliance, however, involves the necessity for great strength in the platforms, which, through friction, are made to resist the force of the recoil.

The destructive effects of this force and the vibration that accompanies it, was tested some years ago, I believe, at Portsmouth, when the firing of a large gun shook to its foundations the work on which it was mounted. My experiments at Edinburgh gave satisfactory evidence of the power of my carriage to destroy that vibration, and it is easily seen how the interposition of a moving fulcrum between the gun and platform, removes or modifies the horizontal strain.

In elucidation of this, I shall quote the following from the memorandum which accompanied Colonel Wray's report to the Select Committee on my experiments:—

"The application of this invention to the heaviest ordnance I conceive to be the most important of any, as it is calculated to give protection and lateral range to the most valuable, and the most powerful ordnance. In approaching this question, the two difficulties which naturally arrest the attention, and at the same time the only ones which would interfere with the adoption of the system, are—

"1st. The difficulty of dealing with a large counterweight; and 2ndly,

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" the difficulty of traversing. With regard to the first, I should wish " to direct attention to the fact that the impact of the recoil is reduced " to a minimum on the counterweight, from the initial velocity of that " counterweight being so small. The movement of the counterweight " increases gradually, representing an animal lift, and the direction of " all the forces brought into play are changed on curves, causing a " destruction of vibration exceedingly conducive to smoothness of " action. These conditions are exactly what are wanted for moving " large weights, and the cubic contents of the counterweight in iron " is not so great as to interfere with the gun being efficiently served."

" With regard to the second difficulty, it will be observed that this " carriage differs completely from others in this respect—that the " horizontal force of the recoil on the platform is removed in the " same manner that it is removed from a common railway when one " locomotive pushes another before it. This being the case, the " strength that is necessary to support the weight in repose is nearly " enough; and as there is no need to provide for horizontal strain, " the difficulty and expense of providing a traversing apparatus with- " out friction, is in a great measure removed."

4th. The power of Traversing.

The traversing apparatus which I have designed for a 7-ton gun is of a very simple nature. It consists of a single complete circular racer, 12 feet 4 inches in diameter, and a central pivot; and in all the other applications as well, the amount of lateral sweep is restricted by no condition. This is probably the most valuable advantage of my system, in conjunction with the protection afforded while the gun is down. It is the free lateral range that makes it so valuable for coast defence, where guns in many positions may be said to be almost useless unless mounted *en barbette*, and it might be added that they would soon be rendered useless also, if mounted *en barbette*, when exposed to an enemy's fire.

For salients and detached works, or where used in my proposed gun-pits, no other system except the cupola can command the same range with the same protection.

5th. Economy in the construction of Works, independent of the Carriage itself.

This is perhaps the most important consideration of any in connection with my invention, and the one on which I would prefer to base my claims to attention from the Government. But as I cannot enter into it with the detail which it deserves, I shall take the liberty of passing it over altogether—merely referring to Colonel Simmons' remarks on the subject already read, and also to the quotation from the professional papers of the Royal Engineers in my last paper regarding the cupola—and suggesting that the more closely this point is investigated, the more enormous will appear the extravagance of the present system, compared with mine.

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6th. Comparative protection from Vertical Fire.

As before stated, my design makes a heavy gun work on a circular racer only 12 feet 6 inches in diameter. The central pivot might be placed in the line of the inner side of parapet; and the front part would then occupy a semicircular recess, the rear part being protected in flank by an ordinary traverse only 8 feet in length. This would limit the exposure to vertical fire to a very small superficies; but it would probably be better to have 16 feet traverses and a square front, as the angles between the traverse and the parapet would be the safest, and at the same time the most convenient place for the men working the gun, and it would still bear favourable comparison.

7th. Comparative protection from Direct Fire.

The protection which my system affords is of a character that has not as yet been given to artillery. In working guns, two conditions which usually conflict with one another have to be obtained; the one is to make the gun formidable to an enemy, and the other is to have at the same time both it, and the men working it, as little liable to injury as possible.

The first condition is obtained by having appliances that expedite aiming and loading, and also those which enable each gun to traverse as large an angle as may be required. The second condition has until lately received very few improvements beyond the old and well-known method of the embrasure, &c. However, improved casemates, the contraction of ports by the use of armour-plating, cupolas, and Lieutenant Bucknill's ingenious system of firing through a false parapet or screen, &c., &c., have each and all their advantages for certain positions, but with one exception, viz., the cupola, they all curtail the power of the gun by contracting its free range; and, therefore, with that exception, what they gain in safety they lose in efficiency, where range is required. My system has the happy peculiarity of combining these two conflicting elements in a high degree.

The embrasure necessitates the breaking and weakening of the parapet. It also restricts its thickness for a given number of guns, not to speak of the mark which these embrasures present to the enemy. Armour-plating on land works, at great expenditure of money, reduces these evils considerably, but by no means entirely removes them; so that on reviewing the position of my invention in this respect, I feel my only competitor to be, the cupola. What can be said in favour of the cupola nearly applies to my system. We are equal in our power of traversing; and in the matter of protection, you will have to decide, after I have stated the exposure in each case.

The cupola is always a mark, and is always exposed, and to very heavy ordnance, its invulnerability is still problematical. Its port,

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though small, is liable to be hit for a certain time. Its gun detachments are annoyed, if not hurt, by the concussion of heavy projectiles. It is of enormous weight, and to avoid a shot in the port, it requires to turn its cheek on the enemy after each round, involving a good deal of labour. On the other hand, my gun, and the men serving it, are absolutely protected from direct fire, except that the gun and one man are exposed while aim is being taken.

When the gun is up to be aimed, it is more exposed than the cupola gun, but the moment it is fired, it is safe.

If a screen be used, the enemy cannot see whether the gun is up or down; I thus draw his fire, the correctness of which must be materially affected by having no definite object to aim at.

The best way perhaps of putting the question is this; would gunners prefer to be shut up in an iron box, only penetrable by the enemy's shot through the port, but liable to injury, in other parts: or would they prefer to fight their guns in the open air, and all under cover, except the man who aims, he being only exposed for a very short time and partially protected by the massive breech of the gun? Are the chances of injury greater in my case, where the gun is only liable to be hit during the few seconds required to lay it, and is in absolute safety the moment it is discharged—or, as in the other case, where the cupola remains a constant mark for heavy projectiles, and runs a continual chance (though a small one) of receiving a shot through the port itself?

I do not care which way this question is answered, as I have other and independent arguments in my favour.

With the exception of field guns, no artillery is brought into action without the artificial protection of a parapet, which is generally raised above the level of the surrounding country, and pierced with embrasures. This parapet is the mark at which the enemy directs his fire, in order that by destroying it, the guns which it screens, may be disabled.

It will at once be obvious that the possibility of dispensing with a parapet without losing command of the front of the battery, would give an advantage of an important kind. This advantage I seek to obtain in its greatest degree by employing gun-pits, in which all the vital parts of the carriage remain below the level of the surface, and the gun itself is only exposed when it is going to be fired.

For coast batteries liable to be opposed to the heaviest artillery in ships, a very strong work is now absolutely required to protect the guns from the terribly destructive effects of modern projectiles, which have a penetration far beyond what was dreamed of when most of the existing fortresses were built; and as accuracy of fire has increased, as well as its power, the guns cannot be mounted *en barbette*.

In order therefore to be efficient, coast batteries must be of great strength, and proportionately expensive, especially when iron is used in their construction.

I wish this to be borne in mind, while I point out that by taking advantage of the natural undulations of the ground, scarping down the rear of hillocks to make them into batteries, and applying the skill of

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our military engineers to use whatever nature has supplied in each place, many positions might be defended on my system from the attacks of the heaviest artillery, at a small percentage of the cost which is now required to construct batteries with iron embrasures, cupolas, &c.; and that notwithstanding the economy of these works, they would be probably as invulnerable as their more expensive rivals.

I have dwelt longer than I should have done, upon the comparative advantages to be gained by my system, as I know that some Officers who are aware of the working properties of my carriage maintain that the object to be gained, is not of sufficient importance to justify any change.

It is true that the change will make a revolution in the system of working heavy artillery, and that change will probably mark an epoch in fortification; but if the change is forced on us by the increased power and accuracy of guns, it is useless to attempt to rest on what is past, and it is best to take the most efficient and economical plan for the future.

In my last paper I stated my strong conviction that my principle must some day be adopted, and I gave as my reason for thinking so, that it is calculated to effect an enormous economy of *labour*, *material*, and *life*. I have for eight years endeavoured to bring my system forward without success, but my failures in doing so, cannot convince me that I am wrong, nor will they make me desist; from my feelings being old fashioned in such matters, I have all along declined to ask for that satisfaction, which I know I could get abroad, before first receiving it in my own country—and I console myself with the reflection that the time will come, when it will only be a matter of surprise that so simple an application, and one so consistent with common sense, was not sooner adopted.

I take this public opportunity of expressing my gratitude, and thanks, to the following Officers, for the encouragement and support I have received from their good opinions of my invention; and for the readiness with which they have at one time or another aided me:—

Lieutenant-General Sir R. J. Dacres, K.C.B., R.A.
Major-General Collingwood Dickson, V.C., C.B., R.A.
Colonel Alaric Robertson, Indian Staff Corps.
Colonel Shafto Adair, F.R.S., A.D.C. to the Queen.
Captain Schaw, R.E., Professor of Artillery and Fortification, Royal Staff College.
Colonel Jervois, C.B., R.E., Deputy Director of Works for Fortification.
Colonel Simmons, C.B., R.E., Director Royal Engineer Establishment, Chatham.

I feel more particularly indebted to Colonel Simmons for his open support, as his experience in actual war, and his high scientific name as a soldier, not only make his testimony gratifying to myself—but convincing to those who do not care to look into the subject for themselves.

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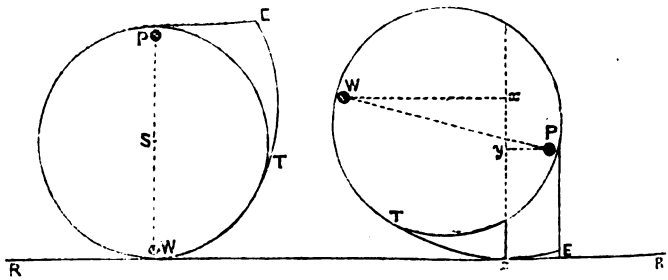
The CHAIRMAN: Perhaps you will kindly explain the model on the table, Captain Moncrieff?

Captain MONCRIEFF: The model before you is not a very perfect one, because it was made at an early stage of the invention, and does not shew it in its best form with recent modifications and improvements, but it is quite sufficient to illustrate the principle. The gun is now in the firing position, and of course the discharge has the effect of running it back. I can, however, better explain the action by means of a suitable diagram or two. Let P represent the position of the gun-carriage axle, and W the centre of gravity of the counterweight; the moving fulcrum always being the point of contact between the wheel or elevator and the rail R R. It follows that while the wheel rests on any part of the circumference W T, the points W and P will be equally distant from the perpendicular to the rail R R at the point of contact between that rail and the wheel: but when the recoil moves the elevator back until the point of contact with the rail is the point x you will



observe that the weight-arm of the lever W x is increased, and the power-arm P y is diminished, and every further inch of recoil lengthens the weight-arm, and shortens the power-arm, until the latter is reduced to nothing; that, however, could not occur, because no discharge could have power to do it. The resistance goes on in an increasing progression, and must inevitably but gradually stop the recoil. I hope I have made that distinct. The force of the recoil sends the gun down, and when down, it is held by a paul. When the gun is to be brought into action the paul is lifted, and of its own accord the gun rises quietly.

Colonel GAMBIER, R.A., Adjutant-General of Artillery: In the case of a heavy gun, how do you load it? I suppose you load it when it is down.

Captain MONCRIEFF: You will see two steps, one on the frame and another attached to the counterweight. The gunners Nos. 2 and 3 stand facing one another upon these steps, in which position they can load.

Colonel GAMBIER: In the case of a 32-pounder?

Captain MONCRIEFF: The case is precisely the same with a 95-cwt. or 7-ton gun. And you may observe that I have brought in here [pointing to another diagram] on the front part of the counter-weight, the appliance I alluded to in my paper for lifting the projectile. When down you place the projectile on it, and the force of the recoil lifts it up to the muzzle into the position in which it will be most convenient for the gunner, and that position can be rectified by the elevating screw.

Colonel GAMBIER: Looking at the model, it would seem to me difficult to bring the shot up to the muzzle of the gun. I mean in the case of a 600-lb. shot.

Captain MONCRIEFF: This is a model of a 95-cwt. gun, and this gun does not bring the shot quite up to the muzzle, but, you see, it brings it very nearly up; but as you may see by my drawings, any projectile, however heavy, can be raised to the desired position.

The CHAIRMAN: Perhaps Captain Moncrieff will be kind enough to take a note of all questions as they are asked, and favour us with his replies to them at the end of the discussion. The subject is one of very great importance, and I trust that

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meeting will not break up without an expression of opinion on the part of some gentlemen present, who are doubtless quite competent to offer observations on the subject, which will interest the meeting. We shall be glad if any one will break the ice, and favour us with their remarks on some of the various points which the paper has put before us.

Commander COLOMB, R.N.: If I get up to make any remarks, it is only to carry out the wish of the Chairman, and break the ice, because it is not properly a naval Officer's business to open a discussion on a subject of this kind. When Captain Moncrieff read his first paper in this Institution, I was very much struck with the whole arrangement, as a wonderful and ingenious application of very simple mechanical appliances to supply what I had always understood previously, to be a great want. I then said that I thought, before we could express any decided opinion on the subject, we should like to have an experiment upon somewhat of a large scale. I think to-night Captain Moncrieff has given us ample grounds for expressing a very decided opinion, and I believe that opinion can only be of a most favourable character. He gives us not only exact details of his experiments, but he gives them not from his own point of view, but from that of independent, qualified witnesses. I look upon that as a very important matter, always to be attended to; because, however ready an inventor may be to disabuse his mind of prejudice, he can hardly fail to give a prejudiced account of his own works. To-night we have not had his own account, but the accounts, as I have said, of Officers qualified to deal with it, and yet perfectly unprejudiced. We, not having seen those experiments, can hardly fail to do right in most fully endorsing the report which he has read to us of the opinions of those Officers. I was surprised to hear Captain Moncrieff say that he understood that there was an opinion afloat that, even supposing guns could be worked in the manner suggested by him, yet there was not a field open for using them in that manner, because the present system of fortification was amply sufficient. Of course I do not attempt to express any distinct opinion upon that subject, but where the cost of fortification is so enormous, and where you have spent enormous sums of money upon different fortifications, and you are still not satisfied that you have done anything commensurate with the requirements of the case, I hardly think we can exaggerate the importance of any system of fortification which will reduce the cost. I do not think we need go any further than to express a disagreement with the gentlemen who expressed such an opinion. There is a question which perhaps Captain Moncrieff will take a note of—I do not put it myself, but it was put to me this morning—viz., as to the difficulty of firing, from the position of the man who has to fire the gun. I think it is quite a matter of detail, and has very little to do with the system, but still it may satisfy some to hear Captain Moncrieff's explanation. For my own part, I expressed a strong opinion when I heard the first paper read, and I can express a still stronger opinion now, viz., I think Captain Moncrieff's invention will lead to a great revolution in the method of working guns.

Captain JASPER SELWYN, R.N.: I should like to make one or two remarks. I should premise that I, like Captain Colomb, formed a very strong *primâ facie* opinion when the first paper was read in favour of the ingenious invention which Captain Moncrieff has brought before us this evening, in its altered form. I firmly believe, with Captain Colomb, that there is not the smallest ground for saying that there is no field for the application of this system. No doubt there is an increasingly large field for such gunnery improvements. Steam has produced such a certainty of locomotion and action, that it is certain that if a war did break out, it would be precisely those points which have not been amply fortified that would be the ones chosen by an enemy for attack, and it is only by being prepared, rapidly and efficiently to throw up temporary defences, carrying even the very heaviest guns, that we can possibly meet the changed conditions of defence and attack. I have no doubt that everything that goes on before us, or anywhere on our coast, is perfectly well known to those whose interest it may be one day—may that day be far distant—to attack us, and I say that the very last place which, as a Naval Officer, I should assail, would be a thoroughly well-plated fort. I should say first of all, that there was very little gained when I had taken it; and, secondly, that there being a thousand other points

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of disembarkation, I should not trouble myself about it at all. I have come some distance to-day in order to have the pleasure of being present at the reading of the second paper of Captain Moncrieff: I have so great, so strong an opinion, that it is one of those inventions which is not only calculated to save millions of treasure to any nation that may adopt it, but also, what is still more valuable, human life. There is a point upon which I did not quite understand Captain Moncrieff, and which he will perhaps take a note of, viz., as to the distance at which he proposes to place his brushwood screen. It is clear that the firing of very heavy guns, or the enemy's fire in return, would very seriously interfere with an abattis, or anything of that kind, and it will be only something of the lightest character, or something that is placed at a considerable distance from the friendly fire, the fire of the gun itself, that would remain. The accuracy of the present artillery fire has reduced it to a matter of certainty, that guns without protection, would be very speedily disabled. This is known from some of the attacks on the Russian forts during the last war, where some of the largest guns were speedily silenced by Captain Coles' guns on rafts. I am not one of the advocates of Captain Coles' system, though I recognise its adaptability in certain cases; but I say as regards the difference between the proposal of Captain Moncrieff and cupolas, even leaving on one side the question of expense and difficulty of transport, I should have no hesitation in deciding in favour of Captain Moncrieff's system. There is another fact which I cannot forget. I have been down at Shoeburyness; I have seen targets fired at there, and I am perfectly certain that any chance shot at any moment may entirely stop the working of any cupola whatsoever, and that as for saying because we have fired at a cupola, or a cupola has been fired at and has not been stopped, therefore it may not be stopped, is to rely far too much on the chapter of accidents. The very slightest burr of the iron-clad deck, the very slightest bulge of the armoured cupola, will at once put a stop to all that smoothness of rotation which is claimed for these forts on pivots. I hope that Captain Moncrieff will be able to tell us also something more than I have yet heard of the possibility of the application of this system to ordinary gun-wheels, so that by substitution of gun-wheels, locomotion may be gained, now that it is so much required, and with regard to the substitution of the weight of the carriage itself, or the shot for the counterweights. I think, if I understand his diagrams aright, he has made some steps already in that direction. I quite clearly understood that the means of raising the shot—very heavy shot, 300 lbs. and 600 lbs., if you please—are much greater than have ever been obtained hitherto—that in all cases, whether it be that the man has to be raised as the gun goes out, or whether the shot has to be raised to the muzzle as the gun comes in, there is ample means of doing that by the very simple mechanical process which is here employed. We must recollect that the increased penetration of shot, as Captain Moncrieff has observed, gives us much thicker embrasures, that the thicker embrasures limit our fire, and that, however thick we may make them, the guns are still very ill-protected in the embrasures. In the case of exposed sea-beaches, we get a power by means of this system, which is most valuable. Gentlemen will recollect, that on a sea-beach there is generally a natural bank thrown up by the waves, and behind that natural bank, all that Captain Moncrieff proposes, can be established. We may send down an army of navvies to any exposed point of the coast, and in 48 hours there may be a battery of formidable guns erected, not known of before, of which the enemy is entirely ignorant, and is, therefore, not prepared to meet. He will be very unwise who attempts, by arguments derived from what I may call, vested interests, to say, "Let us wait till we are attacked, and find out the evils that we have to suffer, before we begin to prepare for them." The Army, too, we must recollect, by means of this system, can fortify themselves, without all the appliance of an engineer's force, formerly necessary. It may, as was done in America, carry out its fortifications on the spot; it may put its guns and riflemen under cover. The protection to the men loading, which is greater, or seems to be greater, in the cupola, is to be taken in connection with this fact, that the gun-pit itself is exactly like a cupola, with the difference of the thickness of the protection which being derived from the earth, is practically immeasurable, and, what is more, costs almost nothing. The protection to the men loading here is absolutely perfect. The protection to the men loading in the cupola, or any system in which

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embrasures are used, is imperfect, and, if it is attempted to be made more perfect by the use of shutters, as in the American war, then the shutter itself is liable to be jambed, and the gun is disabled from that cause. Here there is nothing of the kind. I see, and every Engineer who looks at the plan which Captain Moncrieff has shewn us, must see, that his carriage and elevator are capable of enormous diminution of weight, that the parts can be made of mild steel—steel, which is to be regarded as good wrought-iron; that they can be lightened in every direction, that the strain thrown upon the gun is, as he describes it, one thoroughly taken up by the slow resistance of the weight. It is in fact an utilization in the very best and most important way, of the power which has been hitherto not only thrown away, but has required the force of a large number of men to countervail; the force of the recoil having, in all cases, to be met by the power of a number of men exerted to run the gun out again. There is another advantage which, I think, Captain Moncrieff did not dwell upon, and to which I should be disposed to attach enormous importance, that is, that this system gives us the power of fighting with fewer men. The great drawback to this nation always must be, the small number of men comparatively which it is able to bring into the field. It has wider possessions than, probably, any other equal number of human beings. These it has to protect against attack. I have often lamented, when abroad, the very small number of men that are available for artillery, or useful for military purposes in our distant possessions; but you are obliged to work with what you can get, and he who, as an Engineer economises and makes one man do what ten have hitherto done, has accomplished as much in his way as he who makes a blade of grass grow where one never grew before. I congratulate Captain Moncrieff on the forward steps he has taken, and I express my belief that no possible weight of gun can ever prevent this principle from having its fullest and freest action.

Captain MONCRIEFF: With reference to what Captain Colomb said about those who did not see the necessity for my system, I do not know that it is necessary for me to say much. Probably he may meet some of those gentlemen himself to whom I referred, and have an opportunity of answering their argument much better than I can do. Touching his question about the difficulty of firing the gun, I have heard that difficulty started before, but I believe that it is a matter of such small detail that it is not worthy of being raised as an objection to a system which has so many other advantages. It has been urged that the lanyard could not be pulled at right angles to the friction tube. I can only suggest that if that circumstance interferes with the certainty of firing, it can at once be remedied by placing a small shoulder-piece on the gun, over which the lanyard can be pulled at right angles to the friction tube. Captain Selwyn asked for a more complete explanation of the proposed plan of using a screen. I think that that would be also one of those details that could be carried out on the spot. What I now put forward in this respect is merely a suggestion. Sportsmen well know that they can see game perfectly through a bush when they themselves are concealed from its view. A small screen of brushwood some little way in front of the gun, made in parts, and to represent growing grass, and stretching along in front of the battery, but each part of which could be raised or let fall at pleasure, like the cover of this book, and pulled by a string within the battery, would be sufficient. With regard to the question about using the wheels of the gun-carriage as elevators, I think that my system is very well adapted for that purpose. In the event of our coast defence requiring it, it would be an admirable plan to have the heaviest guns furnished with such wheels. I have not got a drawing here in which such an application is shewn, but I have one which I made for Colonel Lennox, Instructor of Field Works at Chatham, who was impressed with the importance of my invention in siege operations, and he asked me if I could modify my system for siege guns. This is a sketch of the gun I sent him for that purpose, viz., a 40-pounder Armstrong, which is adapted without altering the carriage at all, but merely by adding a few parts. The design of this adaptation, I may say, requires a very slight exercise of the imagination to make it represent such a carriage as Captain Selwyn suggests.

Captain SELWYN: Perhaps you will put it on the wall and kindly explain it.

Captain MONCRIEFF: The parts coloured black represent the gun in a firing position. I may mention that the wheel shown is the wheel of an ordinary siege carriage. I

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take the axle out of the centre of the wheel and mount it upon a block fixed upon the top of the wheel. There is an iron box or basket, which is filled with some material to make up the weight of the gun carriage, and the whole is mounted upon a small traversing platform capable of being put upon a waggon. The traversing platform is very light, and lies on the ground like two or three railway sleepers. The only extras that will be required to convert a common siege-gun carriage, besides the traversing frame, are the box for the counterweight, the blocks to be bolted upon the wheel for the carriage axle, and the curved blocks to be bolted on the tire. With these additions my siege carriage is capable of working, and any siege gun, by having these additions in store, might be converted at any time. All the guns of a siege train need not be made into elevators, but it would be a great advantage to be able to make them so if they were required.

The CHAIRMAN: What supports the trail of the gun in the firing position?

Captain MONCRIEFF: The block attached to the frame; the recoil takes place over that part.

Captain SELWYN: I understand Captain Moncrieff to say that the guns can be moved with the same facility as any ordinary siege train. Is the converse true that the guns could be mounted upon their wheels and used in the ordinary manner?

Captain MONCRIEFF: Yes, and brought into action either way. You made some remarks on the capability of diminishing the weight. My experience has taught me that it is my best policy to confine the experiments as much as possible to such simple forms as those you have seen, and that I must avoid refinements until my principle is taken up, as those refinements are always used against me; but at the same time I must add that I have improvements already designed, and that it will be my greatest pleasure to turn my attention to such matters of detail as may appear desirable by and by.

Mr. W. STIRLING LACON: I fear that I am out of order in asking a question which ought to have been asked before; but perhaps you will point out to us in a few words how you propose to lay guns in that position?

Captain MONCRIEFF: The man who lays the gun stands on a shelf between the cheeks, and at the rear of the carriage, and lays it in the usual way. He has access to this shelf, either by getting on it while the gun is down, and being raised with it, or else he ascends to his place by means of steps for that purpose on the rail, on which the carriage rolls back. When the gun is laid by my reflecting sight, the gunner who lays it stands under and in front of the gun, with his back to the parapet, and in that position he is able to elevate or depress by means of a handle such as those that are used for railway breaks. This handle works the elevating screw. The sight next him has a tangent scale, and enables him to aim with perfect accuracy without himself being exposed.

Captain BURGESS: How would the gun be traversed?

Captain MONCRIEFF: The gun is traversed in the same manner as is the present dwarf traversing platform; if the force required to traverse is inconveniently great, an ordinary purchase might be added to the rear trucks.

The CHAIRMAN: Before the meeting separates perhaps I may venture upon a few observations myself, although the subject has really been almost exhausted by those who have already spoken. There is one mechanical point, however, which has not been mentioned, and which may be important. It is this—that the action of these elevators is so arranged that at the time the gun commences to rise, the motion is less rapid, and when it approaches culmination at the highest point, the converse of that takes place, so that when in the greatest danger, it moves with the greatest rapidity, and the same may be observed in reference to its descent: it moves most rapidly while exposed, and is brought to a state of rest so gradually as entirely to do away with all jerk, and consequently with vibration. That I think is one of the excellencies of the mechanical arrangement; but it is not, to my apprehension, merely a question of mechanical arrangement—it is the principle on which the lecturer has chiefly dwelt, and it is my conviction that it must force itself upon attention. The mechanical details are matters of secondary importance, provided the principle is accepted. For instance, the counterpoise in this model is of a large unwieldy form, and not of a character to give a fair idea of what is likely to be

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adopted. The weights may be brought into a very much smaller compass than they are; they may be made both smaller, and of a material of a much higher specific gravity; but that is a mechanical question. I may state, from what has transpired in this theatre, and the various interesting papers which have been read on the construction of heavy guns, that with regard to construction, we are still in a transition state. Guns which were assumed to be required, of seven tons or more, for throwing shot of a certain dimension and weight, are, I believe, now made very much lighter by the introduction of coiled iron, and steel cores into guns already cast, so that, if I am not mistaken in what I have heard here, and the conclusions which have been drawn therefrom, a gun of 95 or 100 cwt. will perform the same functions as one of 140 cwt. of the Armstrong or wrought-iron pattern. Should this be the case, the action of the mechanism in Captain Moncrieff's elevators will be relieved of one third of the weight on the gun, and the same on the counterpoise. But it is not as regards the arrangement of the mechanism or the weight, or construction of the gun itself that the question at present derives its greatest importance; it is as an engineering matter. The construction of gun-pit batteries at an expense altogether insignificant compared with others, whether cupolas, or protected by iron or in any other way as may be practicable—the construction of gun-pits, I say, at so insignificant a cost, and under so many various circumstances of locality, or especial requirement, appears to me to be of very great importance; and in this light, as an engineer, I view the proposal with especial interest. As regards the application of the system to fortifications, that is to constructions having a command over the country, certain difficulties are introduced which have not, I think, been altogether appreciated. The penetrating power of the guns of recent construction is so great that, for parapets, if constructed of earth, a thickness of 30 feet is necessary:* that is a thickness which renders an embrasure almost impracticable. You could not place a gun in the embrasure of a parapet 30 feet in thickness with any certainty of efficiency. But it may be said that parapets will not be constructed of earth; still they must be constructed of some material which will require a sufficient thickness to make them shot proof, and they involve considerations which have not been referred to by those who have favoured us with their views on this subject, but which will form very important points in the construction of rampart batteries on this principle. They are not difficulties which cannot be overcome, but they are difficulties which will require attention and care. With these remarks, I think I may offer Captain Moncrieff our thanks for the admirable paper which he has read to us this evening upon the gun-pit system. I do hope that by perseverance, and by pursuing his arguments in that modest, yet complete, manner which has distinguished his papers in this Institution, in setting before the authorities the importance of his invention, Captain Moncrieff will succeed in inducing the Government to accept the principle as one worthy of being practically tested; and I am fully satisfied that whenever it may be adopted, it will be found pregnant with important results, and Captain Moncrieff will be awarded the credit which is justly his due for having brought the subject forward, and pressed it to a practical issue.

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* See a paper by Captain W. S. Boileau, R.E., "Notes on the Comparative Penetration of Shot and Shell from Rifle and Smooth-bored Ordnance into Natural and Made Earthworks," Journal of the Royal United Service Institution, vol. ix, page 395.—Ed.

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Evening Meeting.

Monday, May 6th, 1867.

MAJOR-GENERAL J. T. BOILEAU, R.E., F.R.S., in the Chair.

NAME of MEMBER who joined the Institution between the 1st and 6th May, 1867.

ANNUAL.

Wilson, Edmund, Captain R.N. 1*l.*

THE DE-MAGNETIZATION OF IRON SHIPS, AND OF THE IRON BEAMS, ETC., OF WOODEN VESSELS, TO PREVENT THE DEVIATION OF THE COMPASSES, EXPERIMENTALLY SHOWN BY MEANS OF A MODEL.

By EVAN HOPKINS, C.E., F.G.S.

Read by his son, the Rev. E. HOPKINS.

THE magnetism of iron ships, and the embarrassments which it occasions in their navigation, in consequence of the deviations of the compasses, have been lately so fully entered into in the very able and elaborate papers read before this Institution by Staff Commander Evans, as to render it unnecessary to enter minutely into the subject. I shall simply draw attention to some of the leading facts, with a view of showing the present state of this question. Notwithstanding the considerable attention which the subject has received, it is admitted that mariners are still surrounded by difficulties which none of the systems of correction at present in use, can remove. Indeed nothing short of the absolute de-magnetization of the iron affecting the compasses can effectually remove the evils resulting from such an influence, which not only causes very serious errors in their direction, but also reduces their directive power, and thereby increases the heeling errors when sailing in the meridian.

Until lately the system of ascertaining and correcting the errors of the compasses in the Royal Navy, was somewhat different to that adopted in the mercantile marine, as explained in my former paper, but in consequence of the increased amount of iron introduced in the construction of the iron-plated ships, the compass deviation has become

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Fig. 1.

Fig. 2.

Fig. 3.

Fig. 9.

Fig. 10.

Fig. 11.

Fig. 13.

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so large, that the employment of magnets to reduce the amount of deviation has become unavoidable; but the method of correction by magnets, however perfect, is not considered as superseding the construction of a table of errors, by means of swinging, and navigating the ship by that table. The system of having a standard compass and a table of deviations is adopted in the merchant service, as well as in the Royal Navy: therefore as regards the embarrassments attending the navigation of iron ships in thick weather, they are more or less alike in both services.

Again, as regards the compasses themselves, and the position of the binnacles on board iron ships, the Admiralty Instructions are as good as could be wished, but unfortunately we find these instructions frequently as much disregarded in some of the ships of Her Majesty's Navy as in the mercantile marine. No system of correction or remedies could be rendered of any service, if compasses be placed so near iron beams as to prevent them from acting freely.

In my former paper I remarked that—"Many of the errors of deviation attributed to the hulls of the ships may be referred to the magnetism of the steering gear and the deck beams, and the defective manner in which the binnacles are often placed on board iron ships." This fact has been subsequently verified by observations made on board several vessels in the London docks; it therefore follows that, however free the hull may be from any magnetic influence, the compass may still have a considerable deviation, arising from the magnetism of the beams in its immediate vicinity, which magnetism must necessarily be destroyed before the compass can possibly act correctly. We have recently had an example of this kind of disturbing influence from internal masses of iron in H.M.S. "Dryad," a wooden vessel with iron beams. This ship, on her return from a short trial near the entrance of Plymouth harbour, had a narrow escape of being wrecked, owing to the *magnetism of her beams*, which caused a deviation in her compasses of $5\frac{1}{2}$ pts., or say 60° 30′. Indeed, in the majority of cases in the larger vessels, the principal disturbance proceeds from the effects of local masses of iron, and not so much from the hull, if the compass be 20 feet from the sides.

Before I proceed to shew how the hull of any given vessel, or the beams, or any other masses of iron on board, which may disturb the compasses, are to be de-magnetized, I shall first give a brief description of the method, so that the system may be thoroughly understood.

The *de-magnetizing* process is effected on the same principle as that adopted in destroying the magnetism of steel-bar magnets, when they are no longer required to be employed as magnets. As this principle may not be generally known amongst those who have not studied the science of magnetism practically, I shall give a brief description of the process by shewing how magnetic bars are magnetized and de-magnetized by means of a horse-shoe magnet. Fig. 1 represents a prepared steel bar, tempered, but not yet magnetized. If we place small compasses on both sides and within a short distance of this bar, they will not be disturbed, or made to deviate from their meridional direction, and will

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retain their parallelism, as shewn by the arrows. Steel and iron bars, sewing needles, &c., in their normal state, may be placed together without indicating any tendency to attract, or adhere to, each other; but the moment they are magnetized they will attract and unite together into one bundle. This magnetic power of attraction will remain if not destroyed; but if the separate parts be de-magnetized, they will be restored to their former normal or neutral state. If we pass over the bar (figure 1), a horse-shoe magnet from S. to N., with the S. end of the magnet forward towards the intended north end of the bar, so that the magnetic current may pass through the bar from south to north, the bar will acquire polarity; the intensity of this polarity will depend on the power of the magnet, and the number of times it is made to pass over the bar from S. to N. The moment the bar acquires this polarity it will affect the compasses placed in its neighbourhood to a considerable distance, and make the direction of the needles to conform to the magnetic curves, shewn in fig. 2.

If the bar be made of steel, and properly tempered, it will retain this magnetic power permanently. If however it be only a hard iron bar or beam, such as iron ships are made of, the magnetism will become gradually less intense in the course of years; but nevertheless will continue to be of sufficient intensity to cause a great deviation of the compass placed in its vicinity. Therefore it is indispensably necessary to remove this magnetic power; that is to de-magnetize the iron ship, the iron beams, or other disturbing masses of iron, so that the compass may be allowed to act correctly and without deviation.

This highly important object can now be easily and effectually done in the following manner:—

If we refer back to figures 1 and 2 and see how the bar first acquired its magnetism, viz., by means of passing currents through it from S. to N., we may reasonably conclude that if we pass currents through it in a contrary direction, we shall destroy its magnetic power. By reversing the horse-shoe magnet so that we pass it now in the opposite direction, *i.e.*, from N. to S., the polarity of the bar will be destroyed; and if the operation be carefully done, the bar will be restored to its original normal condition, as shown in figure 3. It must be borne in mind that if this contrary action be continued longer than is necessary to destroy its previous polarity, it will acquire a contrary polarity. If however this opposite effect be produced, it may be easily removed by reversing the operation. This is precisely the system I adopt in de-magnetizing on a large scale; whether I operate on the hull of the ship, or on the individual iron beams and other masses of iron near the compasses; and whether I employ ordinary horse-shoe magnets or electro-magnets.

Before commencing the operation, it is necessary that the general character of the magnetism of the hull should be correctly ascertained, and the direction of the magnetic currents of the iron beams accurately noted, as it is evident, that upon the nature of this acquired polarity, the particular course to be pursued in the process of de-magnetizing, will entirely depend.

I will now explain by means of the model, the experiments made on

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board H.M.S. "Northumberland," and furnish a table of the results as far as I was able to carry out those experiments. They were conducted at Sheerness in January last. The weather was extremely unfavourable and very cold, and I was at the time suffering from a very severe illness, which completely prostrated me before I was able to complete the operation. In spite, however, of these difficulties, I am happy to state that the de-magnetization was carried on sufficiently far to prove the perfect practicability of the process, which was the main object of the experiment.

The "Northumberland," had acquired during construction a very strong polarity, in accordance with her position on the stocks. The bow was the north pole, from which magnetic lines radiated outwards from 30 to 60 feet, and the same at the stern as represented in figure 5.

I shall first give the model the same kind of magnetism, in order to show the effect experimentally, and how the hull was de-magnetized.

The deviation of the compass at the place occupied by the poop binnacle on the "Northumberland" was 90° before launching. This is shown on the model, which on being swung while it has this polarity will indicate deviations of the compass placed on the poop, of the following character:—When the head of the vessel has a westerly bearing, the deviation will be east; and when the ship's head is east, the deviation will be west, showing that the north end of the needle is attracted by the stern, or south pole of the ship. In like manner, when the "Northumberland" was swung at Sheerness, the poop compass had a maximum deviation of 53° E. when her head was west, and a corresponding westerly deviation when her head was east, *i.e.*, the north end of the needle was attracted to the stern.

These facts confirm the law originally observed by Dr. Scoresby, and subsequently by the Compass Committee of Liverpool, and noticed by Commander Evans, in his last paper read at this Institution, as follows:—

"The remarkable law of the direction of the force causing the "semicircular deviation in iron-built ships being dependent on their "position in building, was established prior to the application of armour "plates to ships of war. This law, provided the compass is free from "the influence of individual masses of iron, may be thus expressed, "'*the north point of the needle is attracted to the part of the ship which* "'*was south in building.*'"

Having shown the effect of the acquired polarity on the compass, I shall now proceed to destroy it by de-magnetizing the hull. This is effected by passing two horse-shoe magnets along the sides from end to end, in a contrary direction to its polarity, as will be observed. On re-swinging the model it will now be observed that the polarity has been entirely removed, and the compass will now point correctly at all the bearings, without indicating any deviation.

On the "Northumberland," instead of horse-shoe magnets, which are not sufficiently powerful for the immense mass of iron to be operated upon, strong electro-magnets were employed, with two Grove's batteries of five cells each, and passed from end to end in a direction contrary to the acquired polarity, in the same manner as

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shown on the model. This destroyed the polarity of the hull, and affected compasses, placed within a distance of from 8 to 10 feet from the side. Now, had the "Northumberland" consisted of nothing more than a mere iron shell—like the model—or had the binnacles been placed at distances sufficiently far from the magnetism of individual masses of iron beams, etc., then on the polarity of the hull being destroyed, the whole of the compass deviation would have been removed —in the same manner as is done in the model. But as the vessel contains a number of strong iron beams, which had acquired a high degree of magnetism, and within 3 feet 8 inches of which the cards of the binnacles were placed, it is quite evident that these beams, as well as the hull of the ship, had to be de-magnetized.

I shall further explain this by means of an experiment on the model.

The magnetism of the poop and deck beams was first carefully examined before they were touched by the electro-magnets, in order to ascertain the direction in which the operation was to be made in order to produce the desired effect. In the bearing in which the ship then stood, the deviation of the poop compass was about 37° E. The moment the depolarizers (electro-magnets) were passed over two of the beams underneath and near the binnacles, the deviation was reduced to 5° E. I then discovered that the beam on which the poop compass was placed, and immediately under which the two binnacles were situated, was so strongly magnetic that it was the principal cause of the disturbance, and that, therefore, it was necessary that it should be de-magnetized. This beam was unfortunately lined or covered with wood, and could not be properly dealt with, without removing this lining. A part of this was taken off, and the beam was partially operated upon, but not sufficient effect was produced, owing to the above reason, to de-magnetize it entirely.

This inconvenience, together with the severity of the weather and the complete prostration to which I was reduced by illness, rendered it impossible for me to proceed further in removing the magnetism of the iron which affected the compasses. What had been effected, however, was sufficient to prove the complete efficacy of my plan, and that the magnetism of the largest, as well as of the smallest iron ships, can be effectually destroyed.

The steering gear of the "Northumberland" is constructed of brass, to prevent any influence on the binnacles from this source; but this precaution is of little avail, if the iron beams, above and below the compasses, and within so short a distance of them, are allowed to remain in a highly magnetic state. The table, at the end of this paper, shows the degree to which the deviation of the poop and port compasses was reduced on the last day I was able to be on board.

The binnacles should be properly placed at the required distance from iron, and all the beams or masses of iron that have acquired polarity, should be left bare so that their magnetism may be destroyed, and the compasses rendered completely free from all disturbances. There is scarcely any *soft* iron in the frame of an iron ship. It is composed of iron of various degrees of *hardness*, which does not ac-

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quire magnetism rapidly, like soft iron, but when once it becomes saturated with the magnetic power, it will retain it for many years; though its intensity becomes gradually less and less every year, as it is not capable of preserving it uniformly and permanently, like hardened steel. For this very same reason, after the magnetism of the *hard iron* has been removed, it will not return again, unless the ship be exposed to hammering and reconstruction. The retentive power of the *hard* iron of the plates, ribs, and beams of iron ships, has been proved in the case of the "Great Britain" and several other ships, which could be mentioned. During the first few months after launching, a very large proportion of the acquired magnetism, vanishes. As to the alleged effects of the action of the waves on the hull, the concussion and vibration thereby produced, may tend to hasten the gradual weakening of the ship's polarity, but never to *change or reverse* it. Were this the case, an iron ship's compasses would be constantly deviating to the east and to the west on the same course during a short voyage in stormy weather. Those who entertain such ideas could never have made observations on the magnetism of ships at sea. The actual change as already stated is merely the *gradual diminution* of the intensity of the polarity of the hull acquired during construction, and not the *reversal* of the poles. Hence when once the polarity, or the magnetism, of an iron ship is destroyed, it will not return, and the hull will have as little effect on the compass as that of an ordinary Thames steamer.

Although the experiments on board the "Northumberland" were not made under the auspices of the Admiralty, but simply by their permission, yet it is my duty to acknowledge that I have received the greatest courtesy from their Lordships. When I proceeded to Sheerness, in January, to make the experiments, they instructed their Naval Officers to afford me every facility in carrying out the process on board the "Northumberland." I met with the greatest attention from all the Naval Officers. They feel a very great interest in the invention, and are looking forward to be relieved of the embarrassments and risks attending the present system of correcting the deviations of the compasses. In spite of the difficulties already referred to, the severity of the weather and my severe illness, I was enabled to carry the operation sufficiently far to prove the perfect practicability of the de-magnetizing process. I intended not only to complete the "Northumberland," but also to de-magnetize two or three other vessels then in the harbour. I had not the pleasure of seeing any of the members of the Compass Department on board the "Northumberland." I have also to regret, that some of its members are much displeased at their Lordships granting me such privileges, and in feeling such an interest in the de-magnetizing process. They privately maintained that I could not effect the object; but now seeing the effect produced on the poop-compass of the "Northumberland," which they acknowledged in the following terms:—"The maximum deviation has been reduced from 54° to 17°," and seeing that I could easily take away the remaining 17°, they recommended their Lordships that in the next ship I should not be allowed to touch the beams! But these compass errors, and the

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daily increasing dangers resulting from them, are of much too serious a character to be trifled with. Some more practical and efficacious method, than that now in use, to render the compasses of iron ships trustworthy, is urgently called for, quite as much in the Navy as in the mercantile marine. If, therefore, any fatal wrecks should occur (which indeed may happen any day), and it can be proved that they arose from compass errors, and that these errors could have been removed by a simple and effective process, those who resist such a remedy in ships under their charge, will do so at their own peril.

In the memorandum addressed to the Board of Trade, with reference to the magnetism of iron ships is the following remark:—

"The President and Council (of the Royal Society) think it right to "call the attention of the Board of Trade to the serious responsibility "they incur in cases of loss of life and property, arising from the want "of a proper system of compass adjustment, by declining to take the "course which is pointed out." "They cannot but look forward to a "time when the necessity of a proper supervision will be forced on "the Executive by public feeling, excited by some disastrous loss of "human life, traceable to the want of such superintendence."

If the Board of Trade incur a serious responsibility, because they decline to interfere with the supervision of the compasses of the mercantile marine, and without having been furnished with any method by which such evils can be removed, how much more serious must be the responsibility of the Compass Department of the Admiralty in the event of any of H.M. ships meeting with such disasters, should its members resist the introduction of a process which effectually and permanently affects the object. The Admiralty are the owners, designers, and generally the builders of the ships of the nation, and are bound to use every available means in their power to ensure the safety of their navigation. The Board of Trade has no right to interfere with the building and equipment of merchant ships; if therefore an efficient practical remedy be discovered by which the compass errors can be removed, in case of fatal casualties the responsibility will rest on the owners of the ships, and on them alone. Even had the Board of Trade received a satisfactory reply to their application for an efficient practical remedy which could be immediately applied, instead of the mere supervision, and the tentative and experimental process suggested, they could only recommend it to the consideration of shipowners, and remind them of the responsibilities incurred in cases of fatal shipwrecks, traceable to causes arising from the neglect of available remedies. It is known to many, that iron ships are sent to sea in the most dangerous state as regards the condition of their compasses, owing to the disturbing influence of the magnetism of their hulls and beams, especially when new.

In the coal fleet of the north, many disasters occur in consequence of this evil, but which on being recorded, are attributed to the neglect of using the lead. Numerous casualties have occurred in the channels, and several vessels during the last few years have been wrecked, owing to the great deviations of their compasses. Although these facts are now pretty well known, it is supposed that they are necessary

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and incurable evils, inseparable from iron ships, and to which we must become reconciled, as they cannot be removed.

Shipowners, therefore, pay little attention to the subject, and protect themselves by means of their floating policy. The Captains of iron ships are now expected to ignore the use of the compasses in thick weather and in channels, and be guided solely by soundings. Hence in all the recent cases of casualties, some of which were fatal, and which were primarily caused by the deviations of the compasses, and the magnetism of the beams, the captains were reprimanded, or their certificates suspended, because they did not ignore the use of the compass and depend solely upon the soundings of the lead. The public at large are thus kept almost in the dark with regard to the real causes of many of these wrecks. Nothing can excuse the neglect of all precautionary measures to ensure safety on board a ship: but surely such an indispensable and highly important instrument as the compass should have all the attention necessary to render it accurate and trustworthy, and to avoid the possibility of its becoming treacherous and misleading, from the disturbing influence of the ship's magnetism, and its being placed in an improper position.

It behoves Commanders of iron vessels to look after their own interest and the safety of themselves, and the lives of their crew. While shipowners can protect their own interest by their floating policy, however great and irregular the errors of the compasses may be, it is not probable that they will trouble themselves about compasses, or the magnetism of their ships. The lives of crews and passengers are frequently sacrificed in shipwrecks primarily caused by the errors of the compasses, but generally attributed to the want of using the lead, or some other neglect on the part of the officers.

Having studied this subject for many years, and knowing its vital importance to the safety of the navigation of iron ships, I have spared neither time nor expense in experimenting on and bringing the de-magnetizing process to a simple but efficacious and practical issue, so that it may be immediately adopted in the Navy and the mercantile marine.

When furnishing to the Admiralty the particulars of the experiments on the "Northumberland," I mentioned that having satisfied myself of the perfect efficiency of the process, I was now prepared to undertake the de-magnetizing of all the iron ships of Her Majesty's Navy; and also, if required, the training of a staff of Naval Officers to carry out the system.

Reference to the Figures on the Plate.

Figs. 1, 2, 3. *Steel bars* (in a neutral and magnetic state).
Figs. 4, 5, 6. Ship's hull (in a magnetic and neutral state).
Fig. 7. Horse-shoe magnet.
Fig. 8. Electro-magnetic.
Figs. 9, 10, 11, 12. Compasses with reflecting cards.
Fig. 13. Steering axle highly magnetized.

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A TABLE showing the deviations of the Poop and Port Compasses of H.M.S. "Northumberland," before and after depolarization, as far as the process was carried on, 18th January, 1867. Sheerness.

Direction of the Ship's Head.	Original deviation of the Poop Compass.	Reduction by Depolarization. Poop Compass.	Original deviation of the Port Compass.	Reduction by Depolarization. Port Compass.	Remarks.
	° ′	° ′	° ′	° ′	
North	16 0 E.	5 0 E.	20 0 E.	6 0 W.	Columns 3 and 5 show the progress made in reducing the deviation. More than half of this reduced deviation is owing to the binnacles being placed *too near* a highly magnetized beam in front of the poop deck, which was lined with wood, and could not be easily operated upon without its being uncovered. The cards of the compasses should never be placed so near iron as 3 feet 8 inches. They should be placed according to the Admiralty Regulations, about 7 feet from iron. The final destruction of the acquired magnetism requires to be done with care, to prevent a contrary polarity being given to the iron.
N. by E.	7 0 ,,	6 0 ,,	12 0 ,,	5 40 ,,	
N.N.E.	1 30 W.	7 0 ,,	6 0 ,,	5 0 ,,	
N.E. by N.	10 0 ,,	7 0 ,,	2 0 W.	4 30 ,,	
N.E.	18 20 ,,	6 0 ,,	9 0 ,,	3 0 ,,	
N.E. by E.	25 20 ,,	4 0 ,,	17 0 ,,	3 0 ,,	
E.N.E.	32 40 ,,	3 0 ,,	25 0 ,,	3 0 ,,	
E. by N.	39 0 ,,	0 0	31 0 ,,	2 0 ,,	
East	44 30 ,,	0 0	39 0 ,,	0 0	
E. by S.	48 40 ,,	0 0	44 0 ,,	0 0	
E.S.E.	52 0 ,,	3 0 W.	49 0 ,,	0 0	
S.E. by E.	53 0 ,,	6 0 ,,	48 0 ,,	0 0	
S.E.	52 0 ,,	9 0 ,,	47 0 ,,	2 0 ,,	
S.E. by S.	48 20 ,,	10 0 ,,	45 0 ,,	0 0	
S.S.E.	40 0 ,,	10 0 ,,	39 0 ,,	0 0	
E. by S.	26 40 ,,	10 0 ,,	30 0 ,,	3 0 E.	
South	12 40 ,,	8 40 ,,	20 0 ,,	8 0 ,,	
S. by W.	0 30 E.	7 0 ,,	8 0 ,,	10 0 ,,	
S.S.W.	12 0 ,,	5 0 ,,	5 0 E.	12 0 ,,	
S.W. by S.	28 40 ,,	3 0 ,,	16 0 ,,	13 0 ,,	
S.W.	31 40 ,,	0 0	26 0 ,,	12 40 ,,	
S.W. by W.	38 0 ,,	0 0	33 0 ,,	12 0 ,,	
W.S.W.	42 40 ,,	4 0 E.	36 0 ,,	10 40 ,,	
W. by S.	47 0 ,,	7 0 ,,	38 30 ,,	7 0 ,,	
West	49 0 ,,	8 0 ,,	40 40 ,,	4 0 ,,	
W. by N.	49 20 ,,	7 0 ,,	42 30 ,,	0 0	
W.N.W.	48 0 ,,	6 30 ,,	42 20 ,,	0 0	
N.W. by W.	46 0 ,,	6 30 ,,	43 0 ,,	4 0 W.	
N.W.	42 0 ,,	6 30 ,,	42 0 ,,	6 0 ,,	
N.W. by N.	37 30 ,,	6 20 ,,	32 40 ,,	7 0 ,,	
N.N.W.	30 40 ,,	6 0 ,,	32 0 ,,	8 0 ,,	
N. by W.	23 30 ,,	5 30 ,,	26 20 ,,	7 0 ,,	

The CHAIRMAN: This question, viz., that of "the de-magnetizing of iron vessels" is one which affects deeply the general welfare of all who embark on board such vessels It is one which has many points of view, and I dare say some gentlemen here will be glad to offer observations upon the subject, and to raise a discussion, which I hope will be of general use in its bearings upon the very important and interesting question now before us.

Captain INGRAM, R.N.: Will the de-magnetized condition of the vessel continue south of the line?

Mr. HOPKINS, jun.: Yes; we de-magnetize once for all. The polarity never returns after the vessels have been once de-magnetized.

Captain INGRAM: If we swing a ship in our latitudes, and then go south of the

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line, the effect will be reversed. I had the honor of commanding an iron ship, the "Birkenhead," and our greatest deviation was not more than two points, though we had not been de-magnetized.

Mr. HOPKINS, jun.: We could easily take all the magnetism away.

Admiral RYDER: There is one point which Mr. Hopkins has not touched upon, but which will make his system of great advantage to us if it should prove to be perfectly efficacious. I refer to the chance of deviation in an iron ship when she is rolling. I believe that all the methods we have in use at present are fallacious when a ship is rolling. The corrections which we ascertain when a ship is on an even keel are all wrong when the ship rolls; whereas, if Mr. Hopkins succeeds in de-polarizing the ship altogether, his method will be as useful when the vessel is rolling, as when she is on an even keel. I should like also to ask, did Mr. Hopkins ascertain how many beams would have to be de-polarized on board the "Northumberland," did he operate on them all at the same time, and was it a part of the process that the de-polarizing operation should be performed upon all the beams at the *same* time?

Mr. HOPKINS, jun.: There were about six.

Admiral RYDER: Did he operate upon them all at the same time?

Mr. HOPKINS, jun.: Yes. That was part of the process.

Admiral RYDER: You could thus see how you were succeeding, and when you were to stop?

Mr. HOPKINS, jun.: Quite so.

Mr. GROVER, C.E.: There is one question I should like to ask, viz., how this operation of de-magnetizing is practically carried out. We all understand the principle, but is it necessary to employ a number of men to move these magnets? Do they hold on with much strength? Was it an expensive or laborious operation, or very simple? And to what extent had you to extend the operation? Along the whole side from stem to stern?

The CHAIRMAN: Our usual practice is for the gentleman who has read a paper, to take notes of questions that are asked him, and to answer them at the close of the discussion.

Mr. VIGNOLES, C.E., F.R.S.: I think the gentleman on my left (Captain Ingram) observed that the plan now in use answered pretty well, within one or two degrees.

Captain SELWYN: In one particular instance; in that particular ship only.

Mr. HOPKINS, jun.: On a ship the "Birkenhead"—two points.

Mr. VIGNOLES: I beg your pardon, I thought you said two degrees. However, what I want to draw attention to, is this:—By the present mode of correcting the compasses by swinging the vessel, a certain correction is produced; and I understand the gentleman on my left (Admiral Ryder) to say that when the ship rolls very much that is entirely lost.

Admiral RYDER: No, not entirely.

The CHAIRMAN: It is exaggerated.

Mr. VIGNOLES: It is exaggerated. Then, if this process, which has been so simply and so accurately described, and which I think we all understand, has the effect of neutralizing or de-polarizing the iron in the ship, of course, whatever roll that ship will hereafter take, it will be almost self-evident that it would not cause the compass to deviate. If the present polarity of the vessel causes the deviation of the compass so completely, and there is only partial correction obtained by swinging the vessel—

Captain FISHBOURNE: There is no correction obtained. There is only a table of errors; there is no correction.

Mr. VIGNOLES: It is the same thing?

The CHAIRMAN: You ascertain the effect upon the compass.

Mr. VIGNOLES: Exactly. But that table is not to be depended upon, you say, when the vessel rolls. (The CHAIRMAN: No.) Then our course appears to me to be exceedingly clear. If this process which Mr. Hopkins has described is effectual, it would require but a few weeks to set a vessel right. (Captain FISHBOURNE: Quite so.) If it is so simple as he says it is, surely the Royal Society, or all the Societies of England would join in pressing upon the Government, the necessity of

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having the experiment fairly carried out. (Captain FISHBOURNE: That ought to be so.) It is not an experiment which is expensive, and it is a simple one. All that is required is that the vessel to be acted upon shall be thoroughly de-polarized, and then subjected to these experiments.

Captain FISHBOURNE, R.N.: I will endeavour to explain the effects that Admiral Ryder referred to, and why the present system is inefficacious; that is to say, why the corrections are of comparatively little value. Perhaps, however, it is too strong an expression to say that they are not correct; but they do not give a true estimate of the deviations when the ship is rolling. You will have observed, that when the beams were polarized or magnetized, they affected the compass, that is to say, they caused the compass to deviate. Now, take the case of the "Northumberland." It is stated, in a letter from Captain Evans, that the deviation of the "Northumberland's" compasses was, of one, 53, and of the other, 51 degrees. You can understand that if the compass is deflected from its true direction, 45 degrees, the directive force of the compass needle will be reduced one-half. The consequence of that is, that the power which the needle has to retain its position constantly pointing to the north, is reduced by one-half. If the deviation, as was the case in the "Northumberland" at launching, was 90, the needle had no directive force at all to point to the north. Upon setting it oscillating, it would oscillate a length of time. Now, in the case of the "Northumberland," when she is rolling, the directive force of the needle is reduced so much, that it has no power to retain its position, and it moves round with the ship. If the ship goes round, the friction of the pivot will carry the compass with it, because there is no force in the needle to maintain its position constantly; yet here we have it argued by Captain Evans that it is a matter of no moment.

Rear-Admiral Sir FREDERICK NICOLSON, Bart., C.B.: May I ask what that document is?

Captain FISHBOURNE: It is a letter which Captain Evans wrote to the *Athenæum*, in which he denied that Mr. Hopkins had reduced the deviation of the "Northumberland" at all.

The CHAIRMAN: What is the date?

Captain FISHBOURNE: The date is in September, 1866. The fact being, as Mr. Hopkins tells you in his paper, that if the compass placed on the centre line of the ship, be 30 feet from the iron skin, it will not be affected to a large degree, and will not be affected at all by this coating, if there are beams which are magnetized to any great amount. Mr. Hopkins de-polarized the external surface of the "Northumberland." Her compasses were not in their places, but compasses placed on the outside showed that the needles ranged themselves first parallel to the keel of the ship. After the process was complete, they pointed to the pole; previously they had been indicating 90 degrees deviation from the pole.

Admiral RYDER: Was her head north and her stern south?

Captain FISHBOURNE: As she lay in dock.

Mr. HOPKINS, jun.: Just the reverse.

Captain FISHBOURNE: It is not stated here. I take it as I find it. It is admitted by Captain Evans in his Report to the Admiralty that Mr. Hopkins had reduced the deviation from 53 to 17 degrees. Now, you will observe that if the 45 degrees of deviation reduce the directive force of the needle one-half, if Mr. Hopkins reduces the deviation two-thirds, he adds two-thirds of that force to the effective value of the compass needle. No doubt when the ship is rolling, it will not indicate quite correctly; but it will indicate more correctly, because of the directive force being increased by that large amount. If, on the contrary, Mr. Hopkins had been allowed to reduce the whole of that 17 degrees, he would have doubled the directive force of the needle. Now, you can understand, when a ship is swinging round fast, and in a narrow channel, how important it is that the compass shall always indicate truly, and that it shall not travel round with the ship; that you shall be able to ascertain at any moment what is the true position of the ship's head, how many points she has deviated from the point you start from. You cannot have that, where you have compasses so influenced by local attraction that they have little or no directive force at all. Therefore, so far from there being

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any force in the argument of Captain Evans, it is the very reverse. Then he says he would prefer as an alternative, magnets, although he had previously deprecated the use of the magnet (the magnet acting just like these beams—decreasing the directive force). Thus, not only would he not have the ship de-magnetized, the effect of which operation is to increase the directive force, but he would add to the evil; he would multiply it, because he would introduce magnets that would still detract from the directive power of the needle. In point of fact, he would reduce the directive power of the needle to *nil*. So you would find it would oscillate. You will see it here now.

(Mr. HOPKINS, jun., proceeded to show the experiment.)

Admiral RYDER: May I ask Mr. Hopkins what he has done?

Mr. HOPKINS, jun.: I have polarized the model.

Captain FISHBOURNE: He has polarized it, the object being to reduce the effective force of the needle.

Admiral RYDER: Has he put the compasses as they were in the "Northumberland."

Captain FISHBOURNE: He has merely put one. You observe how it oscillates; and if you take it away, you will find how the directive power of the needle towards the north increases, and the oscillations stop; that is to say, it will indicate truly any motion of the ship's head. Its power will be so great that though the ship is rolling, still the force of magnetism will be greater than the mechanical force of the ship, that is to say, the mechanical force through the pivot: the needle will retain its position, it will indicate truly, and you will know what you are about. It is not simply that, however; you have not got a constant quantity to deal with. If you knew your errors, or always measured your errors, you would have some guide; but you have not. From the moment the ship is launched there is a diminution of the magnetism of the ship going on, and it is going on for years. And that is not enough; it is an unequal quantity; you cannot measure it. It varies with the nearness of the magnets to the iron; it varies with the course you steer, with the rapidity of change in the course. These are really all alterations which you cannot provide for. Then, again, the magnets themselves are subject to diminution of power. Placed as they are at right angles to each other, they all three operate to decrease their own magnetic power, and to increase the evil. Common sense dictated at once the sweeping the whole of these away. I do protest against the course that has been taken in opposition in this matter. When a gentleman comes here, takes time about a public question, and offers to exhibit his process in the face of any one in committee, or to explain it to any one, I do protest against subordinates setting themselves up in opposition. We hear that the Admiralty themselves are not opposed to it. They give every facility that is wished for. The Officer under whose eye the experiment was carried on, Captain Cochrane, told me that Mr. Hopkins was so ill that he (Captain Cochrane) told him that he would kill himself: the severity of the weather was so great. Yet what is the fact? When the Report upon this experiment is made, what is it? Instead of allowance being made for this gentleman's illness, it is stated that he was eighteen days performing the operation. Now, I want to know, on a first experiment of such magnitude as this, and on so important a subject as this, when he was operating a great deal to acquire knowledge, why the question of time is to be considered at all? But I will not deal with this. I will just state the facts, and leave you to judge for yourselves. Mr. Hopkins has never recovered himself, and I doubt if he is likely to recover. Captain Cochrane told me he thought he would have killed himself if he had continued his labours.* He remonstrated with him upon the subject; but Mr. Hopkins felt the importance of his experiments, and he thought he ought to continue them. But instead of allowance being made for his illness, instead of allowance being made for the severity of the weather, instead of allowance being made for the fact that he was only able to work three or four hours a day, in this report it is objected that he was eighteen whole days employed upon it. If you take the working hours employed, it would have amounted to three days. But if it had been thirty days, it has nothing to do with the scientific bearings of the question. I really put it to you—does it not

* Mr. Hopkins has since died.—ED.

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mark the utter want of confidence they have in their own opposition when they make statements of that description? I do protest against them. I do sympathise entirely with Mr. Hopkins in his illness, and I think it bespeaks our consideration. I perhaps may have spoken warmly upon the subject; but I do think that public affairs should not be so trifled with, and men's interests so unfairly prejudiced.

Sir FREDERICK NICOLSON: I am anxious to say a few words upon this question. I think it is a matter of the greatest possible regret that Mr. Hopkins is not here himself, as he would have been enabled to give us some more detailed information with regard to the effects upon all the compasses of the "Northumberland." As far as I have heard, the results of his first operations, which, I think, took place in April, or somewhere about then, were that no perceptible effect was produced. Those operations were only on the hull, I think. Am I right. [Mr. HOPKINS, junr.: Quite right.] And they had no appreciable effect upon the compasses. I do not know precisely all that has taken place, since I believe there has been a long correspondence upon the subject. Into that I do not enter, because really I am imperfectly acquainted with it. But, subsequently, Mr. Hopkins received permission from the Admiralty to operate upon the "Northumberland" at Sheerness. I think, as Captain Fishbourne truly said, it shows Mr. Hopkins' great zeal in this cause, that in that terrible weather he operated upon that ship at Sheerness. It must have been a frightful task for Mr. Hopkins. But I think all that we have to consider here, as practical men, is what are the results that have been obtained from those operations? Now, I have not seen any detailed statement of the observations made by the Compass Department subsequently to the operation of Mr. Hopkins. If those operations, on the whole, had no more effect than they had before, in consequence, as Mr. Hopkins stated to us to-night, of the compasses being at too great a distance from the sides of the ship for those operations to have any effect, then I think, so far, the effects are still nothing. But when we come to the other operations on the beams, all, who have even the slightest acquaintance with magnetism, must know that to rub any beams of iron with powerful electro-magnets will, of course, produce very great effects upon the compasses in their neighbourhood.

Captain SELWYN: No; not unless they are polarized.

Sir FREDERICK NICOLSON: Well, I mean if they are done in a proper manner. The question is this—have all these compasses been affected alike? Can the navigator of that ship feel confident that the starboard compass, the poop compass, the port compass, are all pointing in the same direction. I have been told that there is a variation of 4½ points between two of those compasses. [Captain FISHBOURNE: That is not correct.] I am only stating what I have been told by excellent authority. And more than that—that the magnetic force which has been produced upon those beams by the operation of rubbing, has altered considerably; as much, in about two months, as one point in one compass, so that we have here two variable elements of great importance. If we could feel that thorough confidence in the operations of Mr. Hopkins that he feels himself—if we could feel thoroughly convinced that by these operations we are to get rid of, and to get rid of permanently, the greater part of the deviation (not only get rid of it for a time, but get rid of it altogether), then there can be no question that Mr. Hopkins has done us a great service; and if those experiments are unsatisfactory to him, all I can say is that it is a great pity they were not continued. However, I have reason to know that Mr. Hopkins reported on the 24th of January that he had finished his operations. It was in consequence of that report that the operations ceased. With regard to the experiment to-night, I would only say one word. It appears to me that to use a large needle like that, which is so long in proportion to the width of the model and to the magnets along it, it cannot give proper results. I am perhaps not aware what those results are; but I cannot help thinking that that compass card is in a very different position with regard to the iron round it, from what a small needle, which you may call an infinitesimal needle compared with the length of the ship would be with regard to the iron in the hull of a ship. I only hope that if there is any doubt in this matter that those who are able to give Mr. Hopkins further facilities for carrying on his experiments will do so. The subject, as it has been truly remarked both by Captain

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Fishbourne and by the lecturer, is one of vast importance. I do hope one thing —that if there is any correspondence, that it will be moved for by some Member of Parliament, in order that the public may see it. I think it would be of the greatest advantage on all sides that we should clearly know and understand, as we did the other night about turrets and broadsides, what men in an official position think about these things. I am sure when people come together, and these subjects are discussed amicably, the truth is more likely to be arrived at than when officials tie up their reports, and let no one see them.

Captain INGRAM: I think that the present Admiralty would give every facility for all these experiments.

The CHAIRMAN: The question before us is the de-magnetization of iron vessels. Upon that subject we shall be happy to hear what you have to say. We are not here to consider what the Admiralty will do or will not do.

Captain INGRAM: I can only say that I have had an iron ship. Her compasses deviated about two points. I have steered with her in a thick fog, having made every allowance, and hit our mark. Captain Strange swung us. We were swung in Portsmouth harbour and at Sheerness.

Captain FISHBOURNE: But that is not the question.

Captain INGRAM: I thought that the swinging a ship was to find out the deviation of the compass. By swinging the ship you can find the deviation of the compass, and you can allow for the error.

Mr. BELL GALLOWAY: I will make a few remarks in strict accordance with the subject of discussion. I admit that the subject is one of paramount importance. It is a question involving the value of every iron ship in Her Majesty's Navy, and in the mercantile marine of the country. The paper states that, in consequence of the "Northumberland" being built in a certain position, that position necessarily allowed the construction to absorb into it a certain magnetic power. The remedy proposed is to de-magnetize the hull, and thus reduce the ship to a normal condition. There is, however, in connection with the question, I submit, some other considerations. The first thought that strikes my mind is this, that if a ship in a certain position, in a given time, can absorb within itself a certain amount of magnetic power, the same law will affect it when at sea or in harbour. So far as an opinion may be formed upon the merits of the invention, I think generally we shall be agreed that it is quite possible to de-polarize the hull and bring it into a normal condition. But I think it will be admitted that the evil may again recur. [Captain FISHBOURNE: No.] I am only going to say, in connection with that remark, that I am exceedingly glad, and I hope that at every meeting such as this, the primary objects and the value of every plan affecting the interests of the country will specially form part of the observations that are made here. (Question.) If I am to be so frequently called to order, I really don't know how I can proceed. I hope I am dealing with the question, but these interruptions throw me out.

The CHAIRMAN: You are quite in order.

Mr. BELL GALLOWAY: I am exceedingly obliged, but gentlemen will excuse me. I am not a very educated man. I worked with George Stevenson when I was a youth, and I have had to work my way through life. I know well I speak to practical men, and I say it here boldly, that there have been various plans of paramount value and national importance submitted, from time to time, to the several public departments, and that those plans have been met with cold neglect and disrepect, to the dishonour of our nation. Having said so much, which would not have been said but for the little interruption, I come direct to the question. And the question is this, a compensating compass, constructed upon correct scientific principles, is the best in my humble opinion to support and effectively preserve the normal state of every vessel which has been operated upon by Mr. Hopkins, and I give him credit so far, and I submit that, after that, you want a perfect compensating compass, and that that compass can be produced.

Captain SELWYN, R.N.: If you will allow me, Mr. Chairman, to pass to the illustrating board, I shall perhaps, in some points, make my meaning more clear than I should otherwise be able to do. I, of course, join every other speaker in recognising the enormous importance of this subject, not less to those who follow

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the sea as a profession, than to those who are carried on it; and as a very great number of soldiers will be among these, they will also recognise the importance of the subject in this Institution. Now I should wish to point out that if, as some might imagine, we were here merely to listen to a very able discourse, and to see cleverly illustrated the fact, that magnets affect magnets when they are placed near each other, we might go away, feeling that though we had been amused, we had not been taught very much. But I submit that there is a much deeper lesson to be learned. It is that such a thing as induced magnetism exists outside and apart from the natural attraction of a mass of iron. That is, the attraction of an ordinary iron ship may be often quite a different case from that of a ship which, by the operation of hammering, or the meridian in which she has been laid down, or other natural causes, has become herself a great magnet, and is then capable of inducing magnetism in all masses of iron in its vicinity, always of a contrary name. Now the very first illustration I wish to make of that is, to ask you to remember a little instrument called the astatic galvanometer, in which two needles are placed with their poles opposite. The whole object of that arrangement is to produce a needle which oscillates extremely slowly; which has no directive tendency due to the earth at all; which will constantly point east and west, instead of north and south, and which is therefore most sensitive to any electric current passing round it. Now when you take magnets and put them into a ship as correctives of erring magnets, or when you take a Barlow's plate—which, if I draw the compass bowl on the standard compass, as we generally have seen it applied, and as it is still applied, is an iron circular plate placed in that position, in front or rear of, and in close vertical proximity to the bowl—what have you done? You have, it is true, rendered the compass insensible to the magnetism outside it; but you have not less done so with regard to the magnetism of the earth, than with regard to the magnetism of the ship. You have made by your error an excessively sluggish compass, whose evils Captain Fishbourne has by no means exaggerated. So if you place, as is done in the present day in the merchant service, magnets under the deck, you have done precisely the same thing in another direction. By destroying the tendency of the magnet to point to the north pole—(I must be allowed to point out that in using these terms we are always using them wrongly; in fact, it is the south pole of the magnet that points to the north)—we have lessened the tendency of this needle, which is our "guide, philosopher, and friend" to point truly; and we have made it only sensitive to the near actions of bodies which we have interposed. Therefore I say that when the Compass Department adopted such suggestions as the Barlow plate, when they adopted such other suggestions as corrective magnets, and accepted deviations, when they refused to displace such magnets, though conscious that they sometimes only made the errors greater, then we were going in the wrong direction. Instead of eliminating the errors, we were piling up other errors in attempting the removal of those we had already got. If, on the contrary, we take the ship, and we consider her as a mass of iron whose attraction for the compass must necessarily be felt, but whose induced magnetism, which is quite a different thing, is entirely in our own power, so much so that, given any compass at any part of any ship, we can, by properly managing the induced magnetism, entirely do away with the evil effects of it, we shall be proceeding in the right direction. I cannot say that in an iron ship we can make the compass as sensitive as in a wooden ship, for this would be to presume that there is no great mass of magnetic matter or attractive matter near. That we cannot do. But we can do away, by scientific treatment, with the great evil of induced magnetism. This is what Mr. Hopkins has most ably shown us can be done. Whether he has carried it to the extreme point of perfection, which the Compass Department, long as it has existed, ought now to have attained, is quite another question. But I do say, that a body claiming to be a scientific body, as I presume the Compass Department is, should be very far from refusing credence or acceptance to those who come before it with a new plan, which does something which they could never do in their lives before, because he does not at once do the whole of that which they could never do. This is the state of the case at the present time. I do say it is one of those lamentable instances where vested interests make men blind. Unfortunately, I am afraid none of us are exempt from such blindness; but

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I think this is one of those instances where the screw from the outside may properly be put on with pressure, where public opinion may say, "We care nothing whether these were methods which you were taught, and which therefore you believe; but we do care a very great deal whether one life, let alone ten or ten thousand, is or is not sacrificed to the errors of the compass, and to the consequent wrecks of ships." It is not a question which should ever be decided by the Compass Department at all; they are not the persons to do it in any sort of way. For not among those who have sedulously believed from their youth in a certain system, will you ordinarily find the adoption of new ideas. They go in the groove in which they have been taught, but they never adopt new principles. It is too much to expect of human nature. But do not let us allow them to stop everybody else. I want to see this subject taken up fairly by scientific men in a scientific spirit, not in a spirit of partisanship, but because these are great truths, which affect materially the happiness of thousands yet unborn, and because truth is to be sought, though she be at the bottom of the well. Now to follow out this illustration a little further, I beg you to observe that every ship having been made a magnet by the induction process, is herself suspended in water over another great magnet, namely, the earth; and that the familiar instances which we have constantly round us of masses of metal lying for some time in a certain direction, such as pokers, becoming by the mere inductive action of the earth, magnets themselves, are sufficient to convince us that this earth's magnetism is capable of re-acting on the ship's magnetism, and that the errors in the ship's compasses from that source are to be guarded against most closely; not alone by swinging the ship at Sheerness, to ascertain what she is going to do in South America, but by close astronomical observations, combined with a record of those observations, such as to enable us to say how much good Mr. Hopkins or any other person may have done for us, or in how much he may have failed to do it. In this Institution our object can but be, that the course of science should be advanced. I do say that this is one of those subjects which should be strongly recommended, in the face of anything the Compass Department may say, and should be followed out to what the Americans call the "bitter end."

Mr. CORNISH: May I ask if the dip of the needle is correlatively affected by the deviation?

The CHAIRMAN; No. The dip of the needle is the angle which it makes with the horizon, in the plane of the declination, or deviation from the true meridian.

Captain SELWYN: There is another observation with which you will allow me to supplement what I have said before. It is that the beams which before were acted upon having been only in the neighbourhood of certain compasses, would affect them, but could not be expected to affect the whole of the compasses of the ship.

Captain BEAMISH, R.N.: Can you tell us whether a beam in a state of magnetism would have the same effect on a ship's compasses, as the ship's sides have?

Mr. HOPKINS, jun.: A greater, but a different effect.

Captain BEAMISH: A different sort of effect, because the ship is built with her head to the north, and her stern to the south, while her beams run east and west? Are the compasses affected in the same sort of way as they are by the sides?*

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* The following answer, omitted at the time, was subsequently communicated.—ED.

"The magnetism of the transverse beams in vessels built in a N. & S. direction, has been carefully examined by my father, in the case of the "Northumberland." These iron beams which had acquired polarity while in an east and west position—the ship being north and south in building—were found to have, not two dissimilar poles at their extremities, like an ordinary magnet, or like the hull of the ship itself, but *a north pole at each end, and a powerful south pole in the centre.* Immediately over this central south pole of the beam, the poop binnacle of the "Northumberland" has been placed.

This singular feature in the magnetism of the transverse beams has been entered into in Mr. Hopkins's report to the Admiralty, and the nature of these magnetic currents have been minutely delineated in the diagrams accompanying that report."—E. H.

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Sir FREDERICK NICOLSON: I should like to ask you, did you apply the electro-magnets to any of the iron stanchions in or near any of the other compasses?

Mr. HOPKINS, jun.: Not near the compasses.

Sir FREDERICK NICOLSON: Where? perhaps you will tell us in your reply.

Mr. HOPKINS, jun.: I must again throw myself on your kind consideration. I assure you that if my father had been here, he would have been able to answer every question satisfactorily. The first point that has been referred to by Admiral Ryder was whether the process would remove the heeling error. My father maintains that it would; that the whole of the magnetism being taken away from the beam, there would be nothing to affect the compass. Mr. Grover asked the question as to whether it was easy of application. With the assistance we had, we only had four riggers—no other people helped us, and I carried my father's instruments on board—we found it very easy indeed, far easier than I at first apprehended. Sir Frederick Nicolson first of all alluded to the fact that Captain Evans had maintained after my father's first operations on the "Northumberland" that no perceptible change had taken place on the compass. But Captain Evans referred to a compass situated on the poop or in the middle line of the ship. My father was aware of the fact that at that place there was no effect; but inasmuch as the compasses would be exposed to the magnetism of the beams, what my father proposed to do on that first occasion, was to remove the magnetism from the hull; and that compass held within a few feet of the hull on the exterior all round, showed a considerable reduction of the acquired magnetism. With reference to another point to which Sir Frederick Nicolson alluded, viz., what compasses were referred to on board the "Northumberland," as having their deviation reduced:—The poop compass is placed about four feet from an iron-beam; the two steering compasses stand 3 ft. 8 in. underneath the same iron-beam. Of course, it is clear that these steering compasses are too near the iron-beam, whether it is in a neutral state, or whether it is in a magnetic state. But the effect upon the poop compass is recorded in the table which I have already handed in. A corresponding improvement was produced upon the two steering compasses, but not to the same extent, standing as they do, within so short a distance of the beam. From the fact of the beam having been covered with wood, the beam could not be got at.

Captain FISHBOURNE: One-half only.

Admiral RYDER: Could not the wood have been stripped off?

Captain FISHBOURNE: Yes, but they had no authority.

Admiral RYDER: Captain Cochrane had none?

Captain FISHBOURNE: He had nothing to do with it.

Mr. HOPKINS, jun.: Then, it was objected that the standard compass remained exactly in the same state. The standard compass stands about there (pointing); and it was asked, how was it, while there was an improvement upon the poop and the two steering compasses, that the standard compass showed no change at all? That may be answered very simply. The beams underneath the standard compass were left alone, and not touched. So this compass just illustrated the fact, that whilst the hull was de-polarized, no perceptible change took place in the compass unless the beams were de-polarized also. Here four or five beams were de-polarized; this last beam was not completed. A question has also been raised as to whether the effect will last. I think my father met this point. I have here a note with regard to the possibility of the ship, after undergoing de-magnetisation, becoming magnetic a second time. He says it has been proved that such an effect never occurs. The hard iron with which a ship is constructed will retain its acquired magnetism for many years, but when it is once destroyed, it will not return, unless the ship be exposed to re-hammering. I do not think there is any other point that I need now dwell upon. I may state that my father offered that some officer should be sent on board, but it was not responded to.

Sir FREDERICK NICOLSON: In the table you showed us a little while ago, there is no allusion to the starboard compass. Is there any reason for that? There is only allusion to the poop compass.

Mr. HOPKINS, jun.: The reason of that is this:—Before commencing any operation at all, the ship had been swung, and the table of deviations was handed to us.

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That table did not record the deviations of the starboard compass, but only of the port compass, and the consequence was we took that column.

Captain FISHBOURNE: I may mention that the reason why the deviations of the starboard compasses were not given was this, that the indications were so unsatisfactory that they would not record them. They had to shake the compasses to get indications. That shows the advantage of such a table.

The CHAIRMAN: I am sure the meeting will return their thanks to Mr. Hopkins for the very interesting and valuable paper which he has read on behalf of his father, whose absence I, in common with all present, deeply regret. I wish to make one or two observations with regard to the operations which have been performed, not with the view of criticising unfavourably the result we have heard this evening, because I think we must all be satisfied that, as far as the experiments have been conducted, they have been complete, and have been satisfactory also; but with regard to the de-magnetization of the beams, I think it is only fair to Mr. Hopkins to observe, that if in the operation of passing the magnets, they are not carried beyond what may be called the poles of the magnet beam, they produce secondary poles; and, therefore, in these beams, which were only partially stripped, and where the electro-magnets could only be brought to bear upon a certain portion of their length, they could not have produced the same effect which they would have produced if carried beyond their poles. Therefore, if there is any incompleteness in that, it is capable of explanation. Then, with regard to the de-magnetization of the skin of the ship, as far as the experiment this evening has been shown, it must be satisfactory to all present that the effect on the model was complete both ways: first, when the magnetism was induced in the skin of the model; and, secondly, when it was driven out of it by the contrary process. But I do not think the experiment, as shown here, quite represents that which would have been conducted upon a ship, inasmuch as I believe that, independently of the skin which we have here, a ship is constructed upon ribs, that is to say, upon bars of iron, always vertical, or nearly always in a vertical position, but which, under the earth's inducing influence, may become magnetized. I cannot believe that the process which has been performed here upon this iron plate would have the same effect upon an iron ship, plated not only with iron outside, but also with vertical ribs, those vertical ribs being induced magnets. I mention this because in an experiment of this kind we cannot altogether connect the results with the experiments upon the "Northumberland;" but I have no doubt that the results must have been, to a very large extent, successful, or the action of the ship's magnetism upon the compass would not have been reduced from 53 to 17 degrees. I believe there may be in the construction of a ship, that is to say, in the existence of its ribs, a means of return to a state of induced magnetism, which would not exist in a model of this kind. Then, with regard to what a gentleman behind me observed, that in swinging ships you acquire a knowledge of deviation, that is quite true. I merely notice the fact as an apology to anybody whom I may have called to order for making observations not strictly in accordance with the paper. The swinging of a ship is merely a method of determining the action of the ship upon the compass; it has nothing to do with the magnetism of the ship, considered abstractedly. My friend Captain Selwyn has made a highly instructive set of observations upon this subject. There is one point to which he referred, and which I believe we must all consider as the one which a person thrown upon his own resources would naturally adopt in determining what the action of the ship is upon the compass; that is, by astronomical observations. There is one point—it is this, that in any geographical position, to determine what the action of the ship is upon the compass, it will not be sufficient to take the astronomical observation with the ship's head in one direction, to know what the effect of the ship is upon the compass in any particular geographical position; the observation must be repeated with the ship's head in eight, or ten, or whatever number of different positions it may be considered desirable to do so. So it will not suffice to consider the action of the ship upon the compass in one given direction, but it must be taken in a great many directions. I mention this to show that the subject is not quite so simple as it might appear to be. [Captain SELWYN: That is our practice.] I believe Mr. Hopkins wishes to offer some observations before I offer the thanks of the meeting to him.

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Mr. HOPKINS, jun.: There is just one word I wish to say. I should be happy to substitute a smaller compass here, as Sir Frederick Nicolson objected to the size of the needle. A smaller compass would show it rather more accurately from being farther away from the sides, and also from the ribs. With reference to the vertical ribs, the plates are riveted to the ribs, and they form part and parcel of the whole; and as the whole is being de-magnetized, they are affected in the same way. Their magnetism does not extend towards the needle or the centre line to a greater extent than that of the hull itself.

The CHAIRMAN: I will now, with your permission, offer our best thanks to Mr. Hopkins for the paper which his father has been kind enough to send us. The subject is one, as we all admit, of the highest importance, both socially and nationally; and the country owes to all persons who come forward, as Mr. Hopkins has done, giving their time and talents to the development of a question of this kind, their deep and grateful acknowledgments, apart from all considerations of personality, all considerations of official position, and all considerations which may weigh in men's minds, except that one of striving to make navigation as safe as it can be made. This question will have further development from the gentleman from whom we have had this excellent paper to-night, and ere long we shall arrive at results which, if not conclusive, may, it is hoped, be nearly so.

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Evening Meeting.

Monday, February 11th, 1867.

Captain E. GARDINER FISHBOURNE, R.N., C.B., Vice-President, in the Chair.

ON MANNING THE NAVY.

By James Reddie, Esq., Accountant-General's Department, Admiralty.

The Manning of the Navy is a subject which has occupied too much of the attention of the Government during the last twelve years, and has been too often discussed in Parliament and by the press, to render it probable that its importance can now be under-estimated. But even were that possible elsewhere, at any rate in this Institution, where naval and military men "do mostly congregate," expressly in order to advance the best interests of both services, it is certain to be fully appreciated. A cognate matter, and one which can scarcely be regarded as of less importance, the recruiting of the Army, has lately occupied your attention here. There was no discussion upon that occasion; but as there are certain general principles which must govern the regulations established for securing the best seamen for the Navy, that will be found equally applicable for supplying the Army with soldiers, in some respects the discussion this evening may embrace the *personnel* of both services. What is wisely determined as regards the one, can scarcely fail to afford some key towards solving difficulties as regards the other; and it might be well in the present day, if we were to revert more thoroughly to what used to be considered a principle as regards these two great branches of Her Majesty's Service, namely, to regulate their pay and privileges, always with special reference to one another. However different may be the professions of soldiers and sailors, they are still equally alike in the service of the Country and the Crown, and are equally considered worthy of all their well-earned honours by their civilian fellow-citizens. This consideration enhances the importance of our subject. It makes me also all the more sensible of my need of your kind indulgence while thus venturing to bring it before you, and

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it enables me to hope so much from the discussion that will follow, that I may venture to anticipate that that at least may be one merit of this paper.

But, it may naturally be asked, Why, after all that has been said and done of late years with reference to the manning of the Navy, is it now necessary to revert to the subject? Has the problem not been solved already satisfactorily? What more can we now want? Well, Sir, admitting the negative force of these interrogations; admitting that what they imply is to a great extent really true; admitting that much has been done, and well done, for the fleet; and that the naval strength of the country is in such a condition of efficiency, that if it cannot be described as quite perfect, it may be considered as very nearly so; for I believe it may well bear comparison with what it has ever previously been in any time of peace.

The present strength and efficiency, however, of the Royal Navy of England affords one of the best reasons that could possibly be urged for bringing the matter under consideration now, whether in this Institution or in Parliament, and makes the present the very best time for gravely discussing the whole subject.

This question has been hitherto too often left for consideration till matters were far from satisfactory; and new measures have consequently been hastily adopted, sometimes, as it were, under panic, to be almost as rashly abandoned when the immediate danger that suggested them has passed. Besides, it does not follow that because we have now an efficiently manned fleet, and a large Naval Reserve such as we never had organised before, that our future prospects are all we might wish, or that nothing requires to be done to insure that our fleet of the future may be equal to all our wants, or that it will continue like what it is now. It will probably not be denied that there are still some acknowledged difficulties to be met, which have either been experienced or which are anticipated, notwithstanding all that has already been done to secure the manning of the fleet, and to render the Royal Navy popular.

Before proceeding further, however, some explanation may be expected as to this, if not optimist view, at any rate very favourable view of the present state of the Navy.

I am quite aware that there has, even recently, been a good deal of what a naval officer has himself described as "the usual naval growling," both as to the want of seamen and as to the quality of those we have got. Only last Saturday we have in the *Saturday Review* "that the man-of-war's man is not so valuable an instrument as once he was, is the general complaint of naval officers." But then, I must be forgiven for saying, this is really a very old story. In reading through the blue books of the Manning Committee of 1852, and of the Manning Commission of 1859, and taking the evidence exclusively of naval officers on this point, there are two things which have been over-abundantly proved, namely, first that the Royal Navy of England has always been *going from bad to worse*, or "deteriorating," ever since the oldest Admiral now living was born; and secondly, if these opinions were worth anything, that it must actually have *gone to the very worst*

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several times since then! But one may well be sceptical as to both these propositions; because, while we find there are opinions of this hopeless kind in great abundance, there are also equally good opinions on the other side, with not a few actual facts in confirmation of the latter. Even the *Saturday Review* adds the consolation, "that this complaint has often been made before, and has always been disproved at a great emergency under great Admirals."

From the evidence of Sir Byam Martin, when Admiral of the Fleet, before the Manning Committee of 1852,* it will be found that then the only hope of the Navy was considered to be "impressment," though some little was also expected from "liberal bounties." But we know what was all we got when we reverted to the bounty system, seven years after Sir Byam Martin gave his evidence; and it scarcely need now be argued that impressment, with all its old brutalities and injustices, or indeed almost in any form we can imagine, is entirely out of the question for the future. If, then, we hear that now we cannot get volunteers for the Navy; well, you will find in the Appendix to the report of the Royal Commission of 1859 (p. 392), that the year 1778 was considered as "an interesting period," because then the endeavours to obtain volunteers for the Navy "were unsuccessful." And this is just the cry of some alarmists at the present day. But, in fact, I have heard the same cry from time to time during the whole six-and-twenty years I have been connected with the Naval department. Now, although the bounty men of 1859 have been very well abused, as in round terms mostly "land-lubbers and blackguards," the question might be put to any experienced sailor or sensible civilian, Whether it is likely, in the nature of things, that seamen raised by impressment, whether now or eighty years ago, could possibly be any better than the bounty men of 1859? Strong expressions to describe our Navy, whether of the past or present, to praise or censure roundly, are simply natural, if not always wise. We are all too apt at times to think and say "the former days were better than these," and so we need not be surprised to hear the *laudator temporis acti* express himself thus of the Navy.† But with a fleet now, during peace, which numbers about as many men as we had throughout the Russian war ten years ago, surely we ought not to think ourselves very badly off, more especially as at the present time the waste or loss to the service, from deaths, invalidings, desertions, and other casualties, is happily at a minimum.

I will only further premise, that although it is my business to have a good deal to do with statistics relating to the Navy, I do not intend to trouble you much with statistics. There is a table, however, in the Manning Commission's Blue-book, which I think it will be advantageous

* Blue-book. Parliamentary Paper No. 45, sess. 2, of 1859.

† I may also observe that Admiral Sir Thomas Pasley, the Commander-in-Chief at Portsmouth, is reported in *The Times* of 2nd February as saying, that "we have at this instant as fine a body of seamen in the service as England ever possessed." In an important pamphlet also, on *The Naval Expenditure from* 1860 *to* 1866 *and its Results*, published last week, we have the present highly improved discipline and efficiency of the seamen of the fleet recognised.—J. R.

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to have, with some additions, upon record in the valuable *Journal* of this Institution. It gives the numbers of seamen, marines, and boys, voted and borne in each year in the Royal Navy from 1756 to 1857, and also the numbers in the registered vessels of the mercantile marine for nearly the same period. I have completed that table as far as possible up to the present date, and shall append it to this paper. On the walls are also a few of the salient figures to be found in that table, and referred to in this paper, which may be useful as we proceed to discuss the question.

For the sake of distinctness, the subject of manning the Navy may be considered under three primary divisions, viz.:—

1. The boys training;
2. The men serving;
3. The men reserved for service.

A further sub-division, however, may be convenient in discussion, namely:—

1. Our standing, or minimum force;
2. Our contingent, or variable force; and
3. Our reserves.

There is also

4. Our war levies;

but that must be excluded at present almost entirely from consideration.

There is one other most important point which must not be overlooked, and which must be almost regarded as a major proposition affecting the whole question, and that is *the expense of the system*. It ought to be an essential consideration throughout, that whatever is done must be well done; and that the only system we can rationally advocate, whether as statesmen, naval officers, or civilians connected with the service, must be that which is best for the safety of the country, and therefore for the efficiency of the service. But that being taken for granted, surely the paramount consideration must afterwards be economy as to the expense.

No doubt all the money that is required for the Navy will be willingly granted by Parliament and the country, but that must be so large a sum that no waste or unnecessary expense will be or ought to be tolerated. I must make one other observation upon this latter point; for I have heard it said over and over, and, in fact, it has become a hackneyed expression, that the country will grudge nothing for the Navy, and that any amount of money which may be asked for, will be readily granted by Parliament. Now those who employ this language must be reminded, that when it was first made use of by some of the leading newspapers, the fleet was nothing like what it is at present; and it will not do to go on repeating this remark, after all that has been done for the Navy, as if there could really be no limit to what Parliament could or would vote for the naval service.

Moreover, we may be sure that no newspaper-writer ever made use of such language, without virtually and in intention limiting it in this

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sense. It was never intended to be argued that a single penny should be wilfully or unwisely squandered, however much might be freely given to make experiments, when the full results of such experiments were not or could not be previously known. The pamphlet already referred to must convince those who have thought otherwise; and therefore it must be kept in mind that economy must never be disregarded in settling questions like the present. We ought, unquestionably, to have absolutely the *best system* that can be devised; but we cannot possibly have the best system, for that must be one that will last, unless we have a due regard to economy during peace, as well as to efficiency at all times, and especially when war is proclaimed.

The chief object, then, of this paper is to advocate such a system of manning the Navy as will be most effective, and work most satisfactorily during peace as well as during war. Even periodical difficulties or anxieties as to getting men are very undesirable, although in the event they have hitherto always been surmounted. But after efficiency and sufficiency, I have had regard to economy. And I have aimed at dealing with the system generally, and with what we may call principles rather than with points of detail, thus getting rid of many controvertible points. For instance, some may say that now we have a difficulty in getting men in the Navy as well as in merchant ships. Perhaps the only difficulty in the Navy is to get them quite easily and with sufficient rapidity. But, be that as it may, what I advocate, is intended to get over all such difficulties; and even if they do not exist at present, I beg still to claim your attention on other grounds, and in order that such difficulties may never exist. But I wish to deal with broad principles and the general features of the system, and not with details. Because, if the existing system is all that it ought to be, and yet the Navy is temporarily in want of seamen, there is scarcely a question for the members of an Institution like this to consider, but only one for the executive Government and the Admiralty.

I shall also exclude, or will notice only incidentally, questions of discipline and ship-board arrangements, as not coming properly within the range of one who is chiefly conversant with the civil affairs of the Navy, the numbers of its men, and its annual cost. Not to appear, however, to wish to shirk such questions, I had here intended to quote a statement of some of the "grievances" which are alleged to be even now felt by men-of-war's men, upon which I should have made some brief comments, chiefly to shew their groundlessness. The recent pamphlet on *Naval Expenditure* renders this superfluous, so I shall pass on to other matters.

Excluding, however, all such points, and many more, the question is still large enough. So much is already in print on the subject, in the Report of the Committee of 1852, and the Royal Commission's Blue-book of 1859, in the Report of Lord Derby's Confidential Committee on "The Navies of England and France," and in various pamphlets, some by distinguished naval officers, and others anonymously written, that I am driven, in very despair of being able to quote all that might be confirmatory of my views, to dispense with quotation almost altogether,

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relying upon the merits of what is now proposed, and trusting to your knowledge of the whole bearings of the question.

Let us now glance at the present numbers of seamen, marines, and boys in the Royal Navy. For the current financial year, which will end on 31st March next, a vote was taken for no less than 67,850 persons. Of these, 44,114 were seamen, 7,336 boys, and 16,400 marines. The average numbers borne or actually serving in the year have not yet been struck; but I may say they were no doubt within 500 or 600 of the numbers voted, *i.e.*, upwards of 67,000 persons. And in 1865-66, that is the last financial year, there were 67,890 persons on an average serving, or almost the precise numbers voted by Parliament for the present year. We may, perhaps, also venture to surmise that the numbers that will be voted for the following year, to commence on 1st April next, will not materially differ from these figures.

Well, then, it will best enable you to appreciate what a grand peace establishment these numbers represent, if you consider that the average number borne between 1st April, 1854, and 31st March, 1857, was 63,000, and that in the year 1855-56, during the height of the war with Russia, the average numbers borne were only 67,791, or somewhat fewer than were serving last year. But that is not all. From 1854 to 1857 we had no Royal Naval Reserve; while last year that body numbered between 16,000 and 17,000 seamen, in addition to the 67,890 seamen, marines, and boys serving in the Fleet and Coast Guard; and, in reckoning the Coast Guard men, are *not* included the civilians of that force on shore.

If we go more minutely into these figures, the state of things is still more satisfactory as regards the present actual strength of the Navy. All who have studied this question know, that our difficulties, when they have existed, have not been as regards marines or boys, but as regards our seamen. Well, in 1855-56 the seamen voted were only 44,000, as against upwards of 44,000 voted both for last year and this. And again, these 44,000 seamen, we now have during peace, are exclusive of our new reserves of 16,000 or 17,000 men, of whom several thousands would be available for manning the fleet within a few months, *if* war were proclaimed.

Let us take another period for comparison, with our present large force during peace. In 1859-60 only 72,400 persons were voted, when bounty was reverted to, after a long interval, to increase the fleet by 10,000 suddenly. Even including the 6,700 representing seamen out of that 10,000, the total of the seamen voted was only 47,066, though then we had no Naval Reserve. Even next year (1860-61), when the total vote was 84,000, though only 79,000 were borne, the vote for seamen alone was only 56,603, as against our present 44,000 and 16,000 or 17,000 reserve men, together equal to upwards of 60,000.

It is unnecessary to occupy your time with a minute comparison of our present numbers with those of any year from 1816 down to the Russian war, in 1854, and including the so-called China war, between 1839 and 1843; because our present vote of 44,000 *seamen alone*, and

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exclusive of the Naval Reserve, exceeds or equals all the *seamen, marines and boys*, who were serving in *any* year, from 1816 down to 1853-54, except (to be very particular) in the year 1847-48, when 44,969 persons were serving; but then of these only 27,500 were *seamen*, against our present 44,000.

Let us now analyse still further our present force, especially of seamen. What is called our continuous service system, or the making of engagements with seamen to serve beyond the commission of a ship (or five years, if required), with additional pay and advantages to continuous service men who so engaged for ten years, or other extended periods, only commenced in 1853, just before the Russian war. It was founded upon a suggestion of Mr. Pennell, then Chief Clerk of the Admiralty, Whitehall, and recommended by Sir Wm. Parker's Committee of 1852. Now a large proportion of our 44,000 seamen are continuous service men, and form a "Standing Navy," having a permanent character like the marines. The seamen of the fleet, however, must still further be divided into seamen proper, or pure blue jackets, who go aloft and work the guns, in contradistinction to artificers (as shipwrights, caulkers, plumbers, coopers, blacksmiths, armourers, painters, joiners, tinsmiths), and to stokers, and to others called "idlers" on board ship, including the mess room and officers' servants.

Of these pure blue jackets the present numbers serving are in round figures 22,000, and nearly all of them are continuous service men. They form the petty officers, leading seamen, seamen-gunners, and the other able and ordinary seamen of the Royal Navy, in short they are our fighting men *par excellence*. It is the men of this class who require a regular man-of-war's training, in order to be fully qualified for the service. It is as to the supply of such men alone that there has ever been any great anxiety. It is almost exclusively for the purpose of securing such men that boys have been entered and trained of late years in the Navy. The artificers, stokers, servants, also required afloat, do not require to be trained from boyhood in the fleet; and in fact some of them could not be trained and taught their crafts on board ship.

We are thus brought naturally to the first division of our subject: *The Boys' Training.*—Under this category are included the boys serving in the fleet, as well as those borne specially in the training ships; because in the widest sense, all the boys in the Navy are really training, though of course the majority of them are very properly made use of in sea-going ships while thus "training," or learning to be made sailors. Bearing in mind, then, that the object of having boys in the fleet is in order—as it has been expressed—"to manufacture blue jackets" (for we may disregard the few hundred ships' stewards' boys), the question then is, Have we now a sufficient number of boys in the Navy for this purpose? I think we have; and this may be easily made clear.

In round numbers, the boys voted this year were 7,330. The annual waste from deaths, invalidings, and other ordinary casualties may be

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taken at 10 per cent., but it is considerably less. Then 7,330 — 730 = 6,600; and as these boys enter the Navy upon an average when 15 years old, they will grow into men in three years' time. Then, if we divide this number of 6,600 by 3, we have 2,200 as the annual number of boys that will grow into men, and be rated second-class ordinary seamen. In other words we now grow and train some 2,200 men annually, to keep up our number of blue jackets.

Are, then, 2,200 men enough—that is the next question—to supply the waste among our 22,000 pure blue jackets? Again, I answer, Yes. The waste or annual drain, arising from deaths, desertions, invalidings, and other inevitable casual discharges, (and including discharges by purchase, although they may be controlled,) is at present under 10 per cent. But taking it at that rate for convenience, 2,200 men per annum are exactly the number we require to supply this waste among our men; and the number of boys now voted, as we have seen, will supply that number.

I am quite prepared to show, that this estimate of waste, whether for men or boys, is ample. But it will be evident, that were it a little more or less, that would only be a question of detail requiring a slight modification of the above figures, and need not be a question here. I may observe, however, that this average of "waste" may be regarded as remarkably persistent in the Navy. For when Admiral Sir Alexander Milne gave his evidence before the Manning Commission in 1858 (Q. 99), he gave that same per centage as the waste of our seamen then, probably, however, excluding the discharges by purchase. But, including these, at present it is under 10 per cent. After the bounty in 1859 the waste was certainly greater, but that was under abnormal circumstances.

This brings us now to the second division of our subject:—*The Men Serving.* It might be said,—True, we may have boys enough to keep up the present number of blue jackets; but have you enough of these? Is the present number of seamen sufficient? In order to answer that, we must bear in mind the comparisons already instituted between our present fleet during peace, and our numbers during the Russian war, and again in 1859, when we were preparing for war, in our anxiety to maintain peace. We need scarcely expect to see a larger Navy in this country than we now have, unless when war may be imminent or in anticipation. Nor can we quite appreciate the great advantage of having a Naval Reserve, if it will not enable us to reduce our Navy during peace. With a thoroughly available Naval Reserve, the country will naturally expect that our standing force in future should rather be reduced than increased.

I have ventured to hint at the possibility of a reduction in the fleet, not as now advocating its advisability. This is not the place to do so; and it is evident our standing force must be regulated with reference to political considerations and the actual armaments of other countries, even if we have a good reserve.* But still we may well refer to these

* In the pamphlet on *Naval Expenditure*, we must regret to be told, "that all

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tables of the increase and reductions in the fleet, and to the lessons they ought to teach us, that we may at least consider *how* a reduction might best be effected were Europe to become less warlike, and a reduction hereafter be determined upon by the Government, or otherwise found necessary. This is a very important consideration with reference to the present branch of our subject—the men now serving in the fleet; but it has a still more important bearing upon that which follows, namely, *The men reserved for service.*

We must not forget the sudden reduction of the fleet in 1857, when 76,000 men and boys were voted by Parliament for the first three months, and only 56,000 for the remaining nine months of the financial year. No one who has studied the subject at all—no one who has merely read the one blue-book of the Manning Commission of 1859—is likely to forget that 20,000 were thus struck off the votes for the *personnel* of the fleet, and that some 13,000 men were then scattered hither and thither between the close of 1855-56 and 1857-58; while some 5,000 men (nearly) had to be added to the fleet in the very next year, and nearly 20,000 altogether within another twelve months, and almost 6,000 in a year after that. Let me put these figures plainly before you:—

		Reduction on previous years.
In 1855-56, average numbers borne	67,791	
„ 1856-57 „ „	60,659	7,132
„ 1857-58 „ „	54,291	6,368
Total reduction in two years		13,500

		Increase on previous years.
In 1858-59, average numbers borne	59,060	4,769
„ 1859-60 „ „	73,104	14,044
„ 1860-61 „ „	79,018	5,914
Total increase in three years		24,727

It may be added that between 1860-61, when 79,018 were borne, and 1865-66, *i. e.*, to the close of last financial year, when 67,890 were borne, 11,128 men were got rid of. Did time admit, I might go further into details that would still more astonish you, as to these reductions of the fleet. But I will only say, that in a single month's time between April and May 1856, very nearly 5,000 men were discharged to the shore from the ships of the Royal Navy.

Now, these facts are alluded to not to revive an old matter, about which enough of regret has been already expressed;* and not even in

the continental powers are endeavouring to augment their naval strength," and, therefore, that "it may be assumed that the number of our men will not be materially diminished." (p. 65.)—J. R.

* Vide, *Admiralty Administration: Its Faults and Its Defaults;* (Longmans,) pp. 96, 97.—J. R.

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order to say it was wrong that the fleet should have been so reduced. On the contrary, and keeping in mind that it is the Government and Parliament who decide as to this,—we may believe it to have been right and absolutely inevitable; and we may tell the *laudator temporis acti* that it was also ancient and traditional—if that need go for anything. For, between 1762 and 1763, at the close of the war with France and Spain, the actual reduction of the fleet amounted to upwards of 46,000 men. While between 1782 and 1784, after the wars with France, America, Spain, and Holland, the fleet was reduced from 105,443 to 28,878—a reduction of 76,600 men; and upwards of 10,000 more were discharged the service by 1786, that is in two years afterwards. About 65,000 men were also discharged between 1801 and 1803, though no less than 32,000 additional had to be raised the following year. And at the close of the great war with France and America, the fleet was reduced from the highest number ever borne in the Royal Navy, namely, 147,047 men, in 1813, to about half that number, or 78,891, in 1815, and to less than 23,000 in 1817,—a total reduction of no less than 124,000 seamen in the space of four years.

But do not let it be imagined that this reduction of the fleet, or disbanding of men, after a war, is peculiar to England. Precisely the same thing has been done—within months rather than years—by the Government of the United States of America. And, in fact, as already observed, the thing is inevitable. Therefore, in my opinion, no paper on Manning the Navy, would be at all complete, if it did not contemplate and ever keep in mind, as a matter of the greatest importance in all the arrangements which may be made with reference to our seamen, both during peace and war, the fact, that during war and in times of anxiety and threatened danger, much greater numbers of men are required for the service and defence of the country than in times of profound security and peace like the present.

You will at once perceive that a question here naturally suggests itself, What should be done with our best men when they are thus paid-off or disbanded, when it is prudent and therefore proper to reduce our forces? Perhaps a prior question should be asked—for no doubt you wish to deal thoroughly with this subject—What *has been* hitherto done *with* such men?—nay, should it not also be asked, What has been done *for* them hitherto? What was done with the good, and very good men of the 13,000, for instance, suddenly discharged from the Navy and disbanded between 1855-56 and 1857-58? I am sorry to have to reply, *Nothing*. *Nothing* to reward them for their services during the emergency—unless, of course, for the small proportion of them who were entitled to pension by long previous service—and *nothing* to keep them together, under any system or organization, which would have enabled the Government to put their hands upon them in a moment afterwards, when an increase of the fleet was really wanted the following and the succeeding year.

Need this other question be asked? Was it wise or politic, (not to say, Was it quite fair or just?) that all these 13,000 men should thus have been cast adrift, as if their past services during war and their probable future services in some other emergency were nothing to us?

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There can be no doubt what your answer would be, whether it were given by the soldiers, or sailors, or loyal civilians now present. But this is not a matter of feeling, and therefore it must be observed, that nothing was done in this country for the still greater numbers discharged at the former periods mentioned, upon the cessation of sterner wars and larger reductions of the fleet; and nothing has even been done for those discharged from the American Navy in the present day. These changes and chances in the mortal life of the sailor are, in fact, regarded as merely part of the fortunes of war; and the gallant sons of Neptune themselves especially make little of them. That is no reason, however, for the naval officer or the statesman disregarding them. And it must be observed that in former days, "the fortunes of war" had some compensating advantages, which cannot quite be counted on in the present day, or for the future. Without entering upon political considerations, it will probably be admitted generally, that of late years the "adventurous sailor's" chances of prize money have been considerably diminished. Of course we must further admit, that during war, the citizens of a state are expected to make some sacrifices for the common weal; also, that the services of many soldiers and sailors are amply requited by the pay they receive while serving, and that it would simply be out of the question to consider that every temporary soldier or sailor could be pensioned. In these remarks, however, are not included either those wounded or disabled in Her Majesty's service. Chelsea and Greenwich Hospitals would be the reply, were this in doubt as to the past. And for the future, we may be certain that England will never be less generous than she has been—or, at least, has intended to be—towards those who have fought and bled for her, or have been worn out in her service. It must further be observed—for it can serve no good purpose to take an alarmist's view of this most important subject—that when war ceases, and especially a maritime war, commerce necessarily and naturally revives; and thus the seamen who are discharged from our men-of-war quickly find employment in trading vessels; so that, as regards the seamen themselves, the apparent hardship of sudden discharges from the fleet, is redressed by the rapid demand for seamen to man our merchant ships. Indeed, here is one of the great advantages of England's insular position, and of her great arm of strength being in her Navy. For it must be evident that there is less disturbance in the occupations of life, when a seaman is employed in the fleet and in the mercantile marine, than between the employment of the landsman, called from the loom or the plough, to serve in the ranks of the Army as a soldier. And yet we have seen *this* hardship not only cheerfully, but even enthusiastically submitted to, in Prussia at the present time, for the sake of Fatherland and the national glory, with a most glorious and marked success, due chiefly to the wise and economical organization of the *Landwehr*. This ought to read us, and all other nations, a lesson. Surely we, as a maritime nation—sea-girt more thoroughly than Prussia is land-bound—ought to have a Maritime Reserve-force that will equal the Prussian *Landwehr*, or the "Inscription Maritime" of France.

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We are thus brought, you will observe, to the consideration of the third division of our subject, namely—*The Men reserved for Service.* Before, however, entering upon that most important branch of the question; let us review the matter once more under the other divisions already indicated, namely:—

1. Our standing Navy, or minimum force;
2. Our contingent or variable force; and
3. Our reserves.

You will doubtless concede, (1) that the very fact of our having reserves, implies that the Army or Navy cannot always be kept on a war footing, or at a maximum; (2) that the more efficient and available our reserves, the smaller ought also to be our standing or minimum force; and *vice versâ*. There is, however, one other proposition, which is not so self-evident, but which must further be made good, in order to do full justice to the whole bearings of the question; and it is this:—(3) that in order to meet the exigencies of the naval service, and to secure the interests of England and her extended commerce all over the world, even during peace, we must have sometimes a larger, sometimes a smaller force, employed in the Royal Navy, in short "a contingent or variable force," upon which we can always rely to man the fleet, above and beyond our regular and standing minimum force. If this be granted—and I think it may be easily proved, if disputed—then, I venture to argue, that the system of our reserves ought to be such as to provide for such a contingent and variable addition to our standing Navy, as well as for suddenly manning the fleet in greater extremities, or "in an emergency," and when war is proclaimed; or at any rate that our Naval Reserve ought to be such, as never to impede the manning of the Navy at any time. But, conversely, there is this great *primâ facie* argument in favour of this view; that a reserve so constituted might not only thus provide the country with a contingent or variable force which might be suddenly, yet quietly added, at any time, to the minimum force of our standing Navy, but it would also enable us whenever the Navy is reduced, to hold together and reward the most deserving men among those discharged, instead of as hitherto, scattering them hither and thither, and allowing them (not to say almost driving them) to seek employment, not merely in our own merchant service, but in the navies of other countries.

These considerations now force upon us the question—Does our present Royal Naval Reserve meet these requirements? I am obliged to say reluctantly that it does not. I am further forced to call your attention to the fact, since others have pointed it out already, that the reserve as now constituted not only fails to provide us with men when we want them during peace, but that it is now rather tending to stop the contingent supply of seamen, which the Royal Navy has ever heretofore obtained, according to its wants, from the mercantile marine. It is possible that even this effect of the Royal Naval Reserve system, may have been somewhat exaggerated. It is of no consequence to my argument whether it has been exaggerated or not. Some have gone so far as to maintain that it has abso-

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lately stopped our supplies of seamen! I have the following from another source, as accounting for any difficulty there may have been in getting men for the Navy:—

	£	s.	d.
"An A.B. in the merchant service considers it a bad year if he does not get	30	0	0
"If he belongs to the Naval Reserve, his retainer and drilling pay amount to	10	4	0
	£40	4	0
"While his A.B. pay in the Navy is only	28	17	11
"Difference in favour of the merchant service and Royal Naval Reserve	£11	6	1

"The Reserve seaman, after a voyage and if hard-up, can do his "drill whenever he wishes, and will get £1 1s. a-week and his travel- "ling expenses paid. The Reserve appears to be an inducement for "our sailors to quit the Navy when they can."

That is one (and it is a sailor's) view of the case; though it understates the Navy rate of pay and omits its other advantages.* Let us take a broader and simpler view, namely, this:—Not reckoning drill pay at all, for which at least some time and service are actually given, and not taking account of the future pensions, still the retainer of £6 per annum alone, added to the merchant seaman's wages, is of course, an enormous inducement to men to remain in the merchant service and join the Naval Reserve, rather than take a turn of service in the Royal Navy. If we thus "rig the market," as it were, against ourselves, and subsidize the merchant seaman to the extent of a fourth or fifth of his whole wages, need we be surprised if we consequently do have difficulties in getting men to enter the Navy?

On the other hand—for I do not want to "make out a case"—you will be gratified to learn, and it is my duty to put it here on record, that notwithstanding this "rigging of the market," as I have called it, or subsidizing (as it literally is) of the merchant seamen against ourselves, the following numbers of men have actually entered the Navy from the shore between 1861-62 and 1865-66, the first five years† in which the Naval Reserve has been in existence, with all its attractions:—

* As regards pay alone while serving, I may explain that more than a third of our seamen have good conduct badges for which they are paid 1*d.* a-day each; a great number are also trained men and seamen gunners, for which they are paid from 30*s.* to £6 per annum, in addition to their ordinary rate of wages (27 July, 1867).—J. R.

† I take 1861-62 as practically the first year of the Naval Reserve: because in the year ending 31 March, 1861, the average number drilled was only 526. Even in 1861-62 it was only 5,011 (27 July, 1867).—J. R.

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	Seamen of all classes.		Pure Blue Jackets.	
	First entries.	Men who had served.	First entries.	Men who had served.
In 1861–62.....	3,299	3,326	1,414	1,933
1862–63.....	2,888	3,495	673	1,907
1863–64.....	2,887	3,695	594	1,812
1864–65.....	3,331	2,457	795	1,041
1865–66.....	3,024	2,805	485	1,136
	15,429	15,778	3,961	7,829
	31,207		11,790*	

Still holding the balance even, and most sincerely anxious to avoid all unreality—or mere optimist as well as alarmist views—in discussing this important subject, I wish it to be kept in mind that the great pecuniary advantages of belonging to the Naval Reserve are probably now being more and more understood by sailors; and that therefore although 31,200 seamen, including 11,800 pure blue jackets, did as a fact join the Royal Navy voluntarily in those five years, and though "our ships for the last four years have never had to wait for men," it does not follow that as many might be obtained in future if required. But, if not, then it cannot be denied that this is a most serious consideration, and affords an additional reason why we should now consider whether the system of our Naval Reserve can be all that it ought to be, if it has really created, or is likely to create, an impediment and new difficulty, hitherto unexperienced, as regards the manning of the Navy.

Do not, however, let it be supposed that in saying this I wish you to under-estimate the advantage the country has derived from the establishment of the present Royal Naval Reserve. The very knowledge of its existence has, in fact, contributed very materially to that feeling of security which enables us now to consider this whole question in a calm and statesmanlike manner. I for one do not wish to disturb that security, but rather to add to it, and give it a complete and lasting character. I know that in approaching this branch of the question I trench upon tender ground. But as I am rather propounding matters for consideration than proposing measures for immediate adoption, I may speak the more freely. I beg leave therefore to remark, that *the present Reserve is a very expensive force;* and upon reference to the report of the Manning Commission that recommended

* As confirmatory of these statistical facts, I may observe that in the speech of the Duke of Somerset, in the House of Lords, last Friday, he is reported in *The Times* of Saturday (9th February) to have said: "As to men, our ships, for the last four years, never had to wait for men."—J. R.

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it, it will be seen that it was never contemplated, either by the Royal Commissioners or by those who advocated the establishment of the reserve, that it would cost quite so much as it really does; and it was certainly never anticipated that it would interfere with the supply of seamen which the Navy requires to draw from time to time from the merchant service.* If so, this must be a sufficient reason for reconsidering the matter, and rectifying, if necessary, what may be amiss in the present arrangements.

As regards the great expense of the reserve, the retaining fees alone of £6 a-man for 16,000 men amount to £96,000, or nearly £100,000 per annum, while the expense of management, of drill ships, and drill pay is fully £100,000 more; whereas £200,000 was the total amount estimated by the Royal Commissioners as the annual cost of a reserve of nearly double that number (25,000), including for 12 school ships £40,000. Now, even if no more were said as to this expense, you might well be asked to consider, What is it we get for all this money, and whether a better outlay might not be devised? There is another important consideration which must not altogether be passed over, and it is this. Some 16,000 or 17,000 men are now enrolled and under pay in the reserve; but in addition to these numbers, how many during the last five years have there been upon the reserve lists that are now no longer there? How many have already slipped through our fingers after drawing their retainers and drill pay for one, or perhaps two or three years? The waste of seamen in the Royal Navy is carefully ascertained and frankly stated, and it would be interesting and important also to know, with equal precision, what is the average waste in the reserve.

But granting that the Naval Reserve is all we might wish in its character under its present constitution, and that the waste which is inevitable has not been very excessive, the question still remains, Might its constitution not be improved, and might not our Naval Reserve be made a means of facilitating the manning of the Navy in peace as well as during war? I further venture to ask, whether the training prescribed by the regulations for the Naval Reserve, is sufficient to secure that you shall have a force of thoroughly trained men when the reserve is summoned for service and called to join the fleet? Or, would not the paid-off men-of-war's men, with five or ten years' previous service in the Navy, if *they* had been formed into a reserve when the fleet has been reduced, have formed a somewhat better reserve than that which we now possess?†

It must also be kept in mind that what has been called our "contingent or variable force" cannot be provided by increasing the number of boys regularly trained in the Royal Navy, but must necessarily be

* This can be succinctly proved by an extract from the pamphlet on *Naval Expenditure*:—

"The measure [the establishment of the Naval Reserve] has been attended with another good result. It has brought the mercantile marine into closer connection with the Royal Navy, and has tended to remove prejudices which in former years seriously interfered with the manning of our fleets." (p. 20.)—J. R.

† Vide, *Admiralty Administration, &c.*, p. 102.—J. R.

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drawn, as heretofore, from the mercantile marine. It cannot be provided by increasing the number of boys training, because, whatever that number might be, the boys could only grow into men *in time*. They could not become men any faster because you wanted them suddenly, and they *would* grow up into men quite as fast at times when they were not wanted at all. Only a contingent supply of *men* —of sailors ready made—will enable you to make additions to your standing Navy when political considerations require the fleet to be suddenly enlarged; and our system must be such that we may easily, and, it may be, suddenly, afterwards reduce this contingent force, and fall back upon our normal *minimum force*, or "Standing Navy." If, then, our Naval Reserve could be made available to meet such contingencies, it would surely be an immense advantage. And, at any rate, the system upon which our reserve is established ought certainly not to be such as to operate as a hindrance to our obtaining such contingent and temporary additions to the Navy from the merchant service.

If there be now, as some assure us, an unwillingness on the part of merchant seamen of good character, who are eligible for the reserve, to enter the Royal Navy, on account of the unquestionably great advantages which the reserve does offer them, then this unwillingness and undesirable state of things—this practical divorcing of the merchant seamen from the Royal Navy—is likely to increase. And it therefore becomes a very grave matter for consideration, whether the reserve system must not be abandoned, that is, if it cannot be so modified as to change its present adverse influence into a means of facilitating the manning of the Navy whenever men are required during peace, as well as providing a mere exceptional reserve in the case of some long-distant war.

Of course some may be found who at the very first hint of any reform or improvement or modification in the constitution of that force, will be ready to raise the cry that it is sacred, and must not be touched! and that it cannot be, without "breaking faith with the reserve men!" *Here*, I presume, you will be ready in the first instance to hear what is proposed, and afterwards to judge calmly and fairly what is put forward. But I do not hesitate to say, that if it is clearly demonstrated that the Royal Naval Reserve, as now constituted, impedes the manning of the Royal Navy;—or that it places the merchant seamen who enter it at too great an advantage compared with the seamen who are actually doing us service in Her Majesty's ships; then it might be the duty of Parliament and the Government even to abolish the reserve altogether; or, at any rate, that any fresh and more equitable terms which might be deemed advantageous for the interests of the country might fairly be offered, even to the men now enrolled in the reserve, leaving them, of course, quite free to quit the reserve or to continue in it on new terms at their option. This is a matter of far too great national importance not to be considered gravely and most fully in all its aspects.

Let us then look at a few main points affecting this question, as they must present themselves to the seamen of the country, and to all who take an interest either in merchant sailors or men-of-war's men. An

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A.B.'s continuous service pay, while serving in the Royal Navy, is £2 9*s.* 1*d.* a-month, or about £30 a-year. We are now paying some 16,000 Naval Reserve men £6 a-year each for doing nothing, but only promising to serve hereafter, if wanted, during some great emergency; and we pay them besides for the days of their drill, &c., to qualify them for this future service, and we are to pension them hereafter. Add to this the expense of management and training ships, and the annual cost, as shown in the Navy Estimates, is upwards of £200,000. In each five years this amounts to one million sterling; in ten years to two millions. And I put the matter in this way, because suppose (as is most probable) we have ten years of peace subsequent to the time the reserve was instituted, we shall then have paid two millions sterling to and on account of men the majority of whom have never served us, and many of whom could then never serve the country at all.

It may here be observed as to our periods of peace and war, that we had peace from 1815 down to 1840, that is for 25 years. From 1840 to 1843 we had what we call "war with China" for three years. But our highest number of seamen, marines, and boys in the fleet during that period was 43,105—not very much more than half our present numbers during peace. I do not know whether such a "war with China" would be regarded as such an "emergency" as to require us "to fright the isle from its propriety," and to call upon our highly favoured Royal Naval Reserve to give us some actual service. I don't think that sensible people considered that unfortunate squabble with the Chinamen "an emergency," or a threatened danger to Great Britain, any more than they now consider a brush with the New Zealanders or Japanese of very much consequence, except that these "little wars" are known to cost money, and to yield us little benefit or honour. But, anyhow, for 10 years more, from 1843 to 1854, we again had peace; and then came the brief war with Russia for less than three years, at the height of which we have seen we had 67,791 men and boys in the Navy, or somewhat *fewer* than were borne in the fleet last year. The "fleet men" of the Coast Guard are of course included in this comparison, as they did not exist in 1854-1856; and they form a real addition to the naval force of the kingdom. Since the war with Russia, we have had 10 more years of peace, and it is to be hoped we may have twice 10 years more at least besides. And therefore it is important to consider how much we must pay our reserve during every decade of peace at the present rate. In another 10 years it will cost us—that is, if its annual charge be not increased—exactly another 2,000,000 sterling.*

There is another reason why your attention should be called to these figures. Two millions sterling happens now to be just about the sum paid every year as the whole wages of the officers and seamen actually serving in the Royal Navy, excluding boys and marines. (*Vide* Esti-

* You will find it stated in the lucid pamphlet on *Naval Expenditure*, that the present regulations were specially framed, "to relieve the reserve men from the *apprehension* that they might be compelled to serve whenever a sudden addition to our fleets was required." (p. 19.) So it is not in every war we need expect these men to serve. (Vide, also, *Admiralty Administration, &c.*, pp. 117, 118, 130, 131, 132.)—J. R.

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mates, 1865-66.) That being the case, is it not important to reflect that we pay fully one-tenth of this sum to and on account of men who are not serving us at all at present, but only under promise to serve, and only still learning their drill? Nor is this all. The cost of the Naval Reserve is annually more than the pay of all the officers, seamen, and boys of the Coast Guard afloat, or of those ashore; the estimate for 1865-66 being only £129,941 for persons afloat, and £179,690 for persons on shore. Once more; the wages of 8,000 marines actually serving afloat last year amounted to less than the cost of this reserve! It actually costs us about half as much per annum as the whole wages of 16,000 Royal Marines!

Its cost might further be compared with other items in the Navy Estimates; but perhaps enough has been said for those who will think about it; so I pass on, without comment, to some other considerations.

We are under no obligation by the Naval Reserve regulations to continue the £6 retainers when the men are actually called out. Therefore, by the terms of the existing arrangement, the Naval Reserve men will be paid *less* during war than in peace! If, then, men are "backward in coming forward" to fulfil their agreement, under these conditions, it may be a question whether they would be held to their agreement, and whether the country might not feel bound to pay them their retainers in addition to their navy wages, just as they now get them in addition to their merchant wages. Perhaps it would be better to pay them well while thus serving us, rather than now. But, if the retainers were thus continued to the reserve men, it must be evident that an equal boon must then be given to every seaman serving in the fleet! And, if you paid this to your seamen as an annual war-bounty, which it would be, could you withhold it from your marines, who fight alongside of them; or even from the boys, who with them would brave the same dangers? I think not. Well, then, this alone would add about half a million sterling to the wages of even our present numbers, say 67,000; as 67,000 by £6 is = £402,000, to which must be added £96,000 to 16,000 reserve men. But if upwards of 67,000 persons are *now* required for the Navy, during war that number must be greatly exceeded; and so this additional cost in wages would be enormous.

I do not allude, however, to this probable prospective addition to our future war charges, so much to object to the additional cost of the Navy during war, as to advocate a little economy during peace, to enable us to bear somewhat better this unquestionably heavy war-charge. Of late years we have learnt very thoroughly to appreciate the value of the principle implied in the words of Tacitus, *Paritur pax bello*. But surely a little reflection will show that this precept cannot be acted on perpetually, or it would end in the ruin of a state. Such a constant preparation for war would lose its practical influence, and only after all lead to international rivalries, and what have been described as "bloated armaments." *Paritur pax bello* ought only to apply to an abnormal and exceptional state of things. For a continuance and in ordinary times of peace, and having due regard to what we call in modern phrase "the ways and means," that is to "the sinews of war," another precept in homely English ought to have some

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influence, and it is this—*Save well during peace, that you may pay well during war.* Even if we do not grudge an additional half million per annum during hostilities, we may still reflect that every two millions we spend during each ten years of peace, would pay an extra charge of half a million sterling for actual war service during four years!

Without, then, at all under-estimating the value of the *security* which an efficient reserve provides, even if it be expensive, the question still remains, Could not the same, nay, a better, security be obtained on easier terms? I shall not occupy much of your time with propositions as to how the expense of the present reserve might possibly be lessened. We might, for instance, have a war rate of wages for A.B's in the Navy of £36 per annum, besides seaman-gunner's pay, badge pay, &c., to the more highly qualified men; and the Naval Reserve men, instead of being subsidized, as now, during peace, might be only paid while under drill, and have this prospect of high wages in the Navy held out to them during war, and when actually serving—the reserve being made the door for entering the Navy. That might be one way of saving our money during peace, that we might pay liberally during war. Or, if that were not sufficient inducement to get men to enter the Naval Reserve, accustomed as they now are to think of the better terms of the present system, there is another way in which we might save something of our existing heavy peace expenditure. We might limit the number of the paid men in the reserve to, say 5,000 or 10,000 (letting the present number gradually drop to that limit); and in future enter another 10,000 or 5,000 only as probationary reserve men, without paying them any "retainers," except the pay they would receive while under drill and qualifying to get on the *Paid List;* and we might advance them to the *Paid List*, when trained up to some standard, and only as vacancies occur.

But these may be called "half measures," and I do not now advocate either of these compromises, in throwing them out as suggestions for which something might be said, if nothing better could be devised.

There is another and a better way in which our Naval Reserve might be constituted, and which you must have already anticipated when we were considering the dispersion of our seamen upon former periodical reductions of the fleet. The Royal Naval Reserve should be composed exclusively of "blue jackets," who have actually served in the Royal Navy—that is, of already thoroughly-trained "men-of-war's men," who have served at least a commission in a Queen's ship; or, let us say, of seamen having from 3 or 5 years up to 10 or 15 years' service in Her Majesty's ships. Their "retainers" might be at the present rate, or (as I would rather advocate) graduated according to their good-conduct-badges, qualifications, ratings, and periods of service; and these retainers might be regarded in a double light: as rewards for past services, as well as retainers for future service when required. I purposely avoid suggesting particular details, that on the present occasion our attention may not be diverted from principles which are

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more important. But I have sufficiently indicated, that it is intended that the best men would be the best rewarded under the proposed arrangement. These retainers should be paid periodically, as they are to the present Naval Reserve, say half-yearly, or when the men are "at home" between voyages while employed in the merchant service. And they should be paid upon condition that the men shall be ready to rejoin the Navy, not only during an emergency, or when called out by proclamation during actual war (like the present Naval Reserve), but *whenever their services are wanted in the Royal Navy.* Only men-of-war's men of good and very good character, not otherwise entitled to pension, should be eligible for the reserve; and no merchant seamen should *in future* be allowed to enter it, without a previous service of five years in the Navy, or during the commission of a Queen's ship at least. During this service the men would undergo a thorough training in the fleet, and be afterwards efficient reserve men, without the expensive four weeks' drill per annum now prescribed.*

Should the Royal Naval Reserve be modified in its constitution, as proposed, and thus become filled with trained men-of-war's men, one-half its present cost would be saved; and this alone would leave a large margin for any increase to the pay of the pure blue jackets of the Navy, which might further be deemed advisable, in order to make the Queen's service with all these inducements preferred to any other service afloat. There is simply no doubt whatever that the higher rates of pay in the American service, higher at least nominally—for our Navy pay is, in fact, much higher than it seems owing to the present system of paying a lower rate with endless additions, instead of a good round sum—I say there is no doubt that the higher rates of pay and greater comforts in the American Navy, and certainly in its mercantile marine, actually draw off thousands of our best seamen from our merchant service and even from the Royal Navy.

In round figures, our merchant seamen, *excluding* foreigners, number above 300,000; and the very best men of that large body of seafaring persons ought to be our grand source for feeding our Royal Navy with a constant supply of seamen, and especially whenever we require to increase our standing force. The mercantile marine must also in fact be the grand resource, whence our *war levies* are to be drawn, after our reserves are called out. But I am obliged to pass over all besides that this consideration might naturally suggest.

I am glad to know that it is now proposed to carry out to some extent one recommendation of the Manning Commission hitherto disre-

* A few years ago, but before the establishment of the Royal Naval Reserve, I suggested a re-adjustment of the pay of the Navy, with an increase to some of the seamen ratings, with the view of making the Navy preferred to the merchant service, and accomplishing by this means a flow of merchant seamen through the Navy, like what France secures by positive legislation. But at that time one could not hope to complete the plan, by the payment of retainers after the men had taken their turn in Queen's ships. But this has been now rendered possible by the establishment of the Royal Naval Reserve. (Vide, also, *Admiralty Administration, &c.*, p. 111.)—J. R.

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garded, namely, to establish a number of school-ships for the purpose of training boys for the merchant service. This, however, will be chiefly advantageous in a social point of view, as a great benefit to the class of boys intended thus to be rescued from crime, and taken care of, and trained to a useful calling. But it is out of the question to expect that any such system of school-ships can be adopted to such an extent as to supply the wants of our whole mercantile marine. It would also be undesirable, even if practicable, to provide that the race of British sailors should be exclusively augmented from the "waifs and strays"* of our over-crowded populations in cities, while no fair opening is provided for the children of our seamen and of other respectable members of society. Trades and professions, and especially crafts like that of the sailor, are all more or less hereditary, and naturally so. And no artificial means we could devise, we may be very sure, could possibly be so advantageous for training up a race of thorough seamen, as the giving of facilities to our sailors to take to sea along with them, in the vessels in which they may be serving, their own sons, or their nephews, or the children of their neighbours, in whom they would naturally take an interest. But these facilities can only be secured on a sufficiently extensive scale by a certain proportion of boys being required to be borne in our trading vessels.†

There remains, however, an important consideration as regards our sailor boys, whatever plan may be adopted for their increase. Will they remain in the British service after they have grown into men? If not, of course it must be evident that all our labours to increase their numbers will be but labour in vain. It is both true, and quite notorious, that the greater proportion of seamen in the American Navy are British sailors. When Captain Toynbee's paper was recently read at the Society of Arts, it was, however, adroitly argued, with reference to this other fact, that the number of foreign sailors in our merchant service was gradually increasing, that this would prove that our service was preferred, and was not so bad as it has been described. But retorts of this character in an evening's debate scarcely help us to get out of difficulties. To a certain extent, we ought to recognize the fact that there will always be a sprinkling of foreigners in the service of any

* Described in plain language as "pick-pockets off the streets of London," in the House of Lords last Friday. (Duke of Somerset's speech, *Times*, 9th February, 1867.)—J. R.

† The *Saturday Review* of last Saturday (February 9), states this:—"Both on our eastern and on our southern coast, there are families, members of which have served in the Royal Navy or the merchant navy for many generations. No waste of power could be more perverse and more deplorable than to leave this natural aptitude unused and useless."—J. R.

The *Saturday Review*, however, also advocates the new school-ships. It says—"A more valuable boon to the Navy and the nation would be the execution of a project by which the young Arabs of city life might be rescued from the contamination of hypothetical fathers and spurious brothers, &c., to become useful apprentices to a service associated with the popular prepossessions of the most cherished recollections of this country. With many of them the State could not do better than train them up to become sailors in the mercantile, and afterwards in the Royal Navy."—J. R.

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country and in every occupation of life. The small proportion of foreigners in the English mercantile marine (some 9 per cent.!) need not, all things considered, be a source of anxiety to us at present; at all events, it is a very different matter from the very large proportion of British seamen that are to be found in American ships. There can be no doubt, I presume, that our men in transferring their services to the American service, simply consult their own interests. The three chief attractions seem to be simply, higher wages, more liberal rations, and greater comforts in their sleeping places, through the "house on deck," which is common in American vessels. Their treatment otherwise does not seem to be better, or so good elsewhere, as in our own service. There appears to be but one remedy for this unsatisfactory state of things. *The British service ought to be made equal in all respects to the American.* It will be discreditable and almost disgraceful to us, if this country cannot accomplish that. The details, however, are not matters for consideration here. It is clear that the subsidies of the Naval Reserve must tend to check this transfer of our seamen to America and other services, and to bring them back to British ships.

I must just glance at another point. There are some who are of opinion that an enormous increase of boys should be trained in the Royal Navy. Not being a sailor myself, I must quote a well-known sailor's opinion of this—one who has also well studied the subject. He says, "I cannot help repeating the opinion I have often expressed on the impolicy of forming so large a portion of the crews of ships-of-war of young boys, with the view of rearing naval seamen, these boys being for a long time of little value; and particularly when it is found, that but an inconsiderable portion of them adhere to or are fit to be retained in the naval service. The expense of rearing up thousands of boys to manhood, with the view of retaining some, appears to me a very questionable policy; for under proper regulations, the required number of young sailors brought up in the merchant service might be readily induced to serve in the fleet long enough to acquire [a knowledge of] naval duties; and surely it is better that a large number of our mariners should be so qualified by passing through the fleet, than to make the Navy exclusive, and confine it to the few who elect to remain in that service; for these being retained continuously or re-entered, must of course exclude others who might be induced to change their service occasionally."—(J. H. Brown, Registrar-General of Seamen and Shipping, in Appendix to Manning Commission's Report, 1859, p. 364.)*

These opinions I may remark were written before the establishment of the Royal Naval Reserve; and some of them could only be fully justified were the Naval Reserve hereafter to be composed exclusively of seamen who had previously served in the Royal Navy. We would thus, in fact, secure a reserve as well-trained and as available as the boasted *Inscription Maritime* of France.

* One unquestionable effect, however, of training an immensely greater number of boys in the Navy is thus summed up in the pamphlet on *Naval Expenditure*:—"If, indeed, the country should undertake to train merchant seamen at the public expense, a heavy additional charge will be incurred." (p. 65.)—J. R.

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To revert, then, to our main proposition, the establishment of a Royal Naval Reserve, composed exclusively of trained men-of-war's men, I admit it may fairly be asked what I mean by speaking so emphatically of economy, while hinting at some increase in the rates of pay to the pure blue jackets of the fleet now, as well as at having a paid reserve as at present, and probably a higher rate of pay in the Navy during war?

I shall frankly reply to these questions categorically.

1stly. The pay of the Navy is at present most liberal and perhaps sufficient, if all the additions to the nominal rates of wages are taken into account; but by a simplification and re-adjustment of present rates and additions to pay, with a very inconsiderable addition here and there to get rid of fractional differences, I certainly think it possible to establish nominal rates of pay in the Royal Navy, that would bear comparison with those of any other service either in this country or America, and that without disregarding economy.

2ndly. The Naval Reserve I propose will be a reserve of thoroughly trained men-of-war's men; and supposing that they did cost as much as the present reserve, I put it to this assembly of naval officers, whether a Naval Reserve so composed, would not be better worth the money? But, even if the retainers of this thoroughly trained reserve were, on an average, as high as those paid to all the men in the present Naval Reserve, we must remember that all the machinery and expense of their training, and their drill pay and travelling expenses, &c., would be saved,—that is about half the present cost, at least.

3rdly. As to the hint of a higher rate of pay in the Navy during war; to say the least, this is only another way, and, I submit, a better way, of paying "bounty" for war service. Considering also the modern innovations upon ancient war privileges, I am prepared to advocate this as a straightforward, equitable, and, if well considered, an economical measure.

But in answering these questions thus baldly, I have done but scant justice to the proposed reserve. In a few brief sentences, in conclusion, I shall endeavour to show you its other advantages.

1stly. If we have a Naval Reserve which is all we could desire, we could of course reduce our standing or minimum force to less—perhaps considerably less—than that which we now maintain; and it is here we should exercise our chief economy.*

2ndly. A reserve of the kind proposed, the advantages of which become a reward and boon to men who have served in the Royal Navy with good characters, will tend to press our merchant seamen to enter the Navy, in order to become qualified to enter the reserve and share in these advantages. Thus, such a reserve would tend to send men into the Navy, instead of (like the present system) to keep men out of it.

3rdly. Although it is part of the scheme that the reserve men should rejoin the Navy whenever wanted, the practical effect would be that the merchant seamen would generally press forward to fill up your

* As is well known to the initiated, and on the authority of the pamphlet on *Naval Expenditure*, I may observe that "the principle which regulates the amount of the Navy Estimates is the number of men voted." (p. 65.)—J. R.

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vacancies when men were wanted in the fleet, in order that they, by serving their turn in the Navy, might be eligible for the reserve. By some slight management as regards the arrangements made, every reserve man might further be made practically a "recruiting officer" for the Navy, who would induce the merchant seamen to join the fleet when men were wanted, for the sake of future advantages, such as those which the new reserve men themselves would enjoy.

4thly. The proposal to make the amount of retainers depend upon a man's badges, qualifications as a gunner, and rating in the Navy, would simplify the arrangements as to their being paid the retainers, or even double such retainers, when required to serve during war. One badge now represents 1*d.* a-day, or 30*s.* a-year; a trained man's additional pay the same sum; a second-class seaman-gunner gets twice as much, or £3 a-year additional; and a first-class seaman-gunner 4*d.* a-day, or £6 a-year. A man with three badges thus also gets £4 10*s.* a-year in addition to his other pay. Without entering into further details, it is easy to see how these additions to pay might serve to regulate the amount of retainers to men in the reserve, and the extra war rates of wages, which I advocate chiefly on behalf of our best and most efficient men. I do not by any means propose an indiscriminate and general increase of wages or of advantages to all the seamen entering the Navy, either during peace or war. There is nothing in what I recommend that would tend to induce a rivalry in the rate of wages between the Royal Navy and the mercantile marine.

But, on this point, I ought to observe that it will be found from a return in the blue-book of the Manning Commission of 1859 (p. 363), that wages in the merchant service during war, though they may sometimes temporarily rise, are not maintained at higher rates while war continues, but are actually and almost always highest during peace. It has also been often said that the Navy is less popular than the merchant service, from the greater amount of foreign service in the Navy. Were this true, a remedy might be possible; but I find that in the merchant service, out of 195,000 men employed in certain vessels in 1864, 138,000 were in ships engaged in the foreign trade, nearly 12,000 in vessels partly home and partly foreign, and only 45,000 in vessels exclusively in the home trade, *i.e.*, about one-fifth of the whole.—(Annual Statement of the Trade and Navigation of the Kingdom, 1864, p. 448.)

I must now conclude, reserving many other points, in order to give time for discussion; and I have purposely reserved many explanations which might have been given in elucidation of the views I have inadequately ventured to advocate; thinking it better to reply to objections which may be actually raised to what has been advanced, than myself to select objections, and answer them in anticipation. I shall only further say, that in bringing this question forward, my only wish is to discover what may be best for a service which I regard as one of the noblest under the Crown, and the most important for the security of the British Empire.

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The CHAIRMAN: You will allow me to express your thanks to Mr. Reddie for his admirable and lucid paper. We shall be very glad if any gentleman will make any remarks upon it, and bring out the points of this important subject.

Rear-Admiral A. P. RYDER: Considering the great importance of the subject, I think it would not be respectful to Mr. Reddie to attempt any discussion at this late hour of the evening. I would suggest, with your permission, that we take the opinion of the members present, and if they approve it, that we adopt a course that has been adopted on a previous occasion, viz., to ask the Council to allow the paper to be printed, and copies to be distributed to those persons who may wish to take part in the discussion, and after a short interval to have another meeting for full discussion.

Commander W. DAWSON, R.N.: I think this is a very proper recommendation, for it is exceedingly difficult in a matter of figures to go into the question at once.

Captain SELWYN, R.N.: Will the course proposed preclude our going on with the discussion this evening?

The CHAIRMAN: No. It is open to any gentleman to make any remarks that he may wish now; and then there might be an adjournment for a full discussion on the paper when printed.

Commander W. DAWSON: It is exceedingly difficult to follow the number of figures in a paper which we have not before our eyes, and I shall therefore not attempt to enter into the *minutiæ* of the question now, as I hope to be able to do when we have the paper in print. It appears to me that the subject of manning the Navy divides itself into two parts; firstly, with reference to peace, and secondly with reference to war; and in discussing the numbers of men required, I think it is important we should distinguish clearly between those who are *bonâ fide* seamen, and those who may be classed as artificers and stokers, and those who are marines. As far as I can see from these figures, there is one-third of each of these classes required. In dealing with figures in the merchant service, I think it would be advisable if we could have the numbers similarly separated for the purpose of reference. Because it is very difficult to understand where the number of 350,000 seamen said to be in the mercantile marine, come from. I have not been able to find them anywhere. It would be a very good thing if we had the actual numbers classified, because the crews in the merchant service are variously composed, as in the naval service. There is a class of domestics, another of artificers, another of firemen; and it would be as well if these were separated from the list of foreigners and of British seamen in the merchant service. The figures I have before me do not distinguish between these classes. I think, however, this distinction ought to be thoroughly understood. We are told, for instance, that the foreigners in the merchant service amount to only 9 per cent. of 350,000. That may appear a very small percentage, if that 350,000 are all actual seamen; but if there are only 106,000 British and foreign petty officers, able seamen in the British service, then the proportion of foreigners will be very much larger. In dealing with figures, it shows that we must be careful how we twist and turn them. We must have the figures before us before we can enter into the merits of a question like this. What we have first to arrive at is, to discover what our probable wants are. Now, I think to instance the number of seamen employed in the Russian war does not advance the argument at all. The Russian war was not a maritime war. It was simply a yachting cruize up and down the Baltic, and though there was a little fighting in the Sea of Azoff, it was in a small way, and had not the magnitude of a maritime war. The figures we must look to are those of 1814; there has been no real maritime war since then. The total numbers then, were, I find, 147,000. Taking the proportion of one-third marines, one-third artificers and stokers, and one-third seamen, we would arrive then at an idea of what we would now require.

Mr. REDDIE: You had then no stokers.

Commander DAWSON: I am using these numbers in reference to the present time. And I think it must be patent to any one who goes into the matter at all, that we will require a great many more men, hereafter; not because our ships require more men, but because in 1814 there was not a flag upon the ocean that could contend with us anywhere. But hereafter we may have to contend against a powerful

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maritime nation, or against two or three that may combine against us. We have had, for instance, such a thing as France and America combining against us before, and we might have such a thing happen again. Or we might have a rising maritime nation like Italy, her fleets manned with Genoese and Adriatic seamen, and commanded by an Italian Tegethoff, combining with other nations against us. Then, I say, we must be prepared to meet one or more maritime nations, and to contend with them in a struggle which would be more severe than any that befell us since the battle of Trafalgar. We shall want a great many more men than before. The question is, where are we to get these men. If we take 180,000 men as our requirement, and suppose that one-third of them are to be seamen, according to the present regulations, one-third marines or soldiers, and the other third stokers and artificers, it becomes a very large subject of inquiry as to where these men are to come from. I do not think the propositions that have been made to-night to secure us a reserve that we can fall back upon in case of a sudden maritime struggle, will meet the requirements of what I think is a very large case.

The CHAIRMAN: Would you propose 80,000 men for the reserve, because it would require that number to make up the deficiency?

Commander DAWSON: No, I think not. There would be 60,000 seamen required for the service if one-third of the whole are to be seamen. It is a question—a very grave question—whether we should not also have a reserve of stokers and artificers. But, confining our attention entirely to *bonâ fide* seamen, the Royal Navy has, in round numbers, about 20,000 seamen now. We have, within five years, reduced our naval force by 9,000 *bonâ fide* blue jackets; so that there are only 20,000 now afloat. The question is, where are we to lay our hands on 40,000? We leave out of the question for the moment those contingent seamen, whose numbers oscillate in time of peace. I think Mr. Reddie has brought forward one very good suggestion to supply a part of this reserve. But I would carry it a little further. My idea of the reserve, speaking of men-of-war's-men is this, that every continuous service seaman when he has completed his ten years, unless he holds a petty officer's rating, should be liable to be discharged. Therefore, we should be able to discharge them at the end of ten years without feeling the loss. We should never have to call upon the merchant service to supply us with men during peace, but we should supply the merchant service with our own ten-year's men; and these should receive small pensions on condition that they shall serve afloat, and shall not take to cab-driving and omnibus-driving, and so on. Unless you have some rule about serving afloat, you will find that persons who have been seamen will take to driving cabs in London, and other land employments, as many have been doing for many years past. I think that would form a very valuable reserve; but we cannot make it sufficiently numerous in a day or a night. It would take a great many years before we could form a considerable reserve in that way; and at any time—(I do not know that I can now enter into the figures, and say what numbers it would eventually reach, it is a matter of simple calculation)—it would only reach a limited number, and would never in itself provide the numbers required in time of war. I think, therefore, we must also fall back upon that most invaluable body of seamen—the Royal Naval Reserve. Whether the Royal Naval Reserve is conducted on the most economical principles or not I do not know. There is one thing to be said of all reserves, be they militia on shore or sea reserves, that they must be paid for, and must cost money. The total of that money added up for a number of years must be considerable, but may be regarded as an insurance fund. The question is, is that insurance worth paying? If you can get these men in large numbers at the outbreak of a war, then, I think, you will have paid a good insurance. Another valuable feature of this Royal Naval Reserve, I think, consists in its breaking down the partition wall of prejudice which exists among merchant seamen against men-of-war. Merchant seamen are now taken on board a well-conducted training ship; they are placed under the orders of naval officers, and they find that naval officers are not negro drivers, and that a ship-of-war is not a prison; and they go away with their prejudices broken down. There is another prejudice which we also get over, which is the prejudice that exists in the mind of naval officers against having anything to do with merchant seamen and merchant officers. If we can break down that wall of partition which now divides

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the two services, it will be most invaluable. (The CHAIRMAN: I don't think that at all.) Well, I don't know. There is a sort of professional jealousy in all professions, and I think we have got our professional jealousies as much as other people. Supposing you adopted the principle of manning the Navy in time of peace that I speak of, so that we never should require to get men from the merchant service, a good deal of objection that has been raised to the reserve would be got over. We would supply the merchant service instead of the merchant service supplying us. On the contrary, to my mind it is a great pity that the Royal Naval Reserve is so very limited in numbers. We have got only 16,000 men, but they are the cream of the merchant service—the very best of the merchant service. I have been on board one of the training ships; I have seen those men training guns under different officers; and I must say I was excessively pleased with the way in which the work was done. It was done efficiently—thoroughly well. It might not have been done in the fly-away style in which men-of-war's men are brought up to do it; but it was done thoroughly, and I should be proud to have command of a ship manned by such men as those. I say it is a great pity that, instead of being 16,000, it is not 48,000. For I look upon it that 48,000 is the least number that we should try to obtain from the reserve. Now it is a question how that can be done? I am told the regulations are drawn up too tight, that we should not be so strict in our requirements, and that if we were not quite so strict in our requirements we might perhaps get more men. This brings me to the number of 350,000 men. How is it that if there are 350,000 able seamen—

Mr. REDDIE: Not able seamen.

Commander W. DAWSON: That is the question.

Mr. REDDIE: 350,000, including seamen, officers, firemen, stokers, foreigners, everybody.

Commander DAWSON: These classes do not come into the question.

Mr. T. GRAY, Board of Trade: I may perhaps set you right about numbers. Do I understand you to say there are 350,000 men in the merchant service, including all ranks? The number of men, boys, stokers, petty officers, engineers, Lascars, foreigners, and other persons. Everybody, all told, throughout all the ships of the United Kingdom of Great Britain and Ireland (but not including her dependencies) amounts to 197,643.

Admiral ERSKINE, M.P.: It is not according to the Board of Trade returns. If you look at the last Board of Trade returns, you will find the number is 350,000.

Mr. GRAY: I think it would be as well to look at the numbers carefully before the next meeting.

Mr. REDDIE: I have not got the Board of Trade returns here, and I do not think Mr. Gray has given the correct numbers; but here are the returns from the blue-book of 1859, furnished by Commander Brown, registrar of merchant seamen. The total number of seamen and boys serving in the Royal and mercantile Navy, excluding marines, was 322,000 in 1857.

Mr. GRAY: In the Royal Navy?

Mr. REDDIE: And mercantile Navy. In this return there were in the registered merchant ships belonging to the British empire 284,000 men and boys in 1857, and they have got up to 350,000 by the returns that Mr. Gray was kind enough to send me. It is a very heavy book, and I have not brought it with me; but there are certainly 350,000.

Mr. GRAY: Yes, but the 350,000 includes all sorts of men in ships in British possessions abroad, that never come near to the United Kingdom at all.

Commander W. DAWSON: It only shows, when we have such great authorities speaking to so wide a difference as 190,000 and 350,000 men, the necessity of having these figures before us.

The CHAIRMAN: It is not a difference, but Mr. Gray has read the return wrong.

Commander W. DAWSON: As I said at the beginning, we must try to distinguish between what we actually want in the shape of blue jackets, and what we want in shape of artificers and firemen. Now, able seamen and petty officers are the same thing; they are equally qualified. It seems to me that there are about 106,000 able

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seamen in the merchant service, taking it in round numbers. We are very glad to have firemen, and it is a question, as I said before, whether we ought not to have an organised reserve of stokers and artificers. But if there are 106,000 able seamen, it seems odd that, with all these advantages which are held out, of £10 a-year, &c., &c., we cannot get a larger reserve than 16,000 men. For my part, instead of finding fault with the Naval Reserve, I wish to see it three times as numerous. Then, if we had 48,000 men, we might perhaps be able to lay our hands on 30,000 or 40,000 in case of war, for we must allow a large margin for persons whom we could not get. It is a very grave question whether it would be better to increase the reserve and reduce the force of the Navy; but when the force of the Navy is being reduced, I think it is an important consideration as to which part of the force ought to be kept up. During the last five years there has been a reduction of about 9,000 *bonâ fide* seamen in the Royal Navy. That seems a very large number.

Mr. REDDIE: You reduced the fleet by 11,000 in that time.

Commander W. DAWSON: I think it is a great pity that in times of peace we cannot settle what the standing Navy ought to be. We can, however, reduce the Navy when necessary, by discharging the men over ten years' service with a small pension, and putting them into a reserve. That seems to me the legitimate way of getting over the difficulty of the contingent increase and decrease in peace; and that men, after ten years' service, may be retained when temporarily necessary, but should be liable to discharge into a reserve, with short service pensions; an extra number of boys being trained up to maintain the constant overflow of seamen into the mercantile marine. At this hour of the night, and as there are other gentlemen to speak, I will say no more.

Mr. GRAY: In order to be accurate, I think we should look into the returns; and I shall have great pleasure in verifying Mr. Reddie's figures. But I think he makes a mistake in including in his figures everybody on board ship. The men qualified to enter the Naval Reserve are able seamen, and I think that is the number we should take to work upon, and not foreigners, Lascars, stokers, firemen, and idlers. To arrive at true results, we should take the exact number of able seamen in the merchant service, as that is our only true reserve.

Mr. REDDIE: I may explain the reason why I took gross numbers in the Navy in some of these tables. I have not drawn any argument from them at all; but I have used them merely to show that the fleet was reduced by those numbers. And you must always recollect that the other persons in their way are necessary on board ship, although they are not blue jackets.

The CHAIRMAN: It struck me that Mr. Reddie was not going into detail, and going into numbers would be going into detail and leaving the principle, which is the real point, untouched. His real argument rested on the principle of economy. If the present system does bribe men to stop away from the Navy,—if it has that effect, the present system is indefensible. It is money thrown away; and if you cannot get men to come even after they are in the reserve, it is money thrown away again. These are the questions to be discussed. Because you will never get two men to agree as to the number of men that you require in any given war. But the principle of obtaining a reserve is really one that you can discuss, and arrive at a conclusion that will be worth something. The others will be mere opinions, the vaguest opinions, that will be worth nothing. It struck me that that was the line Mr. Reddie was taking; and I think it would be quite worth while rather to consider that in any future discussion, than to go off about numbers, which really, to my mind, amount to very little. Nevertheless, I am sure you will allow me to thank Mr. Reddie for his paper.

Captain SELWYN: Perhaps the meeting will allow me to say a few words on this subject, as I shall probably not be able to be here on another evening, and I have turned my attention to it for several years past. I hold in my hand a pamphlet which was republished from the *Nautical Magazine*, about six years ago, and which I wrote with reference to this special question. While I entirely agree with the Chairman that figures and facts may be made to take any face or any formation their manager chooses, like soldiers, I also agree with Captain Dawson, that we are very far from having a sufficient number in the Naval Reserve, while I dis-

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agree with him entirely as to the constitution of that Naval Reserve. The first thing that we ought to lay down as a principle in this case is that our reserve of seamen for the defence of the country ought to be co-equal—never should be less than the whole available force of seamen, who call themselves Englishmen, or English subjects. The next question arises, how shall we obtain them, with the least stress during war, with the utmost facility during peace? As to figures, I might go over the question as to the size of our ships now requiring more men, as to prizes being taken requiring more men to man them, and as to a thousand different points in which the figures may prove to be utterly fallacious. I do not go into those. I utterly refuse to go into figures referring to ten, twenty, forty years ago, as being in the slightest degree satisfactory to-day, any more than to calculate the wages which a labourer had forty years ago would be a fair or just measure of what we owe to our seamen now. It is the fact that the price of all skilled labour has gone up, and that if you wish to be well served you must not ask how little you can give, but what is the fair market value of such labour, and what therefore you ought to pay for it. With these preliminary remarks, if gentlemen will permit me, I will just read one or two remarks referring to what I believe the true system :—"Let lists be opened at all "the ports of volunteers for the Navy under a new system, to be continued till the "total number so enrolled reaches, including those actually serving in the Navy, or "so many of them as choose to enter, the number of 100,000 seamen, or any other "number deemed sufficient for all war purposes." I say, take them if you can co-incidentally up to the full amount of men serving in Great Britain and her colonies :— "Then each year estimate the total number required for the service of that year; "place them on full pay, and use them as required. Let the pay be a fair remune- "ration, a fair market price, for such labour, and not made up of pennies here and "pennies there, which a favourite may get, and a faithful drudge may miss—and "adopt some more simple plan of provisioning than giving a man more than he can "eat, and paying him the difference. Then, let the remaining seamen have leave "for one, two, or three years"—(this you must recollect was written some six or seven years ago; to a certain extent, you will see how far it is in accordance with the present ideas)—"with the understanding that a retaining fee, a sort of half-pay, will "be accruing to them during their absence, and will be paid to them on their return "within the specified time—to be forfeited if they do not so return. If war be "imminent, retain all who are coming home, and let no more go out. I need scarcely "expatiate to any one who knows the habits of seamen on the security of the *moral* "tie you would thus have to the absentees, nor on the well-known fact that the best "seamen are those who have been everywhere, and seen everything, aye, from a "fishing boat to a pirate. Having by such means made the entry to the Navy a "boon, we may then easily keep up the discipline in it to the highest point, although "reducing the corporal punishment to the lowest possible amount, by conferring on "all captains and officers commanding a full power of discharge of *proved* and "incorrigible offenders, without any other check than this :—that an officer com- "manding, the discharges from whose ships were constantly in excess, should be "always liable to be displaced from the command, after fair trial. Officers under "the present system will do one of two things: either they will make 'cooked' "returns—(I hope this is not often the case)—or they will abstain from punishment "where they know it ought to be inflicted—that those returns may not seem unduly "large. I will put a case. A leaves a ship from ill-health or other causes, in which "his mistaken kindness, or easy temper, or the cause I have before mentioned, has "induced a slackness of discipline, under which no ship can be 'smart' or even "'happy.' B relieves him, puts on the screw, and finds to his disgust that his "punishment returns being large, are animadverted upon in no pleasant terms by "his superiors. The natural result is, that he says, 'Oh, it's no concern of mine, I "didn't love punishment. Let the discipline go to the dogs.'" That is a point that I ought not to enter upon, as it affects discipline. But recollect the discipline of the Navy, and the way in which it is kept up affects the way in which you get your men.

Mr. REDDIE: I did not go into "grievances" or discipline, because I was prepared to show that the discipline is not at all complained of by our seamen. It does not affect the question; and therefore I did not go into it.

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Captain SELWYN: I have only further to remark that if you cannot induce seamen to enter from the merchant service by their knowledge of that service, you have yet a possibility of making seamen in excess of any demand. You may train boys; you may even recur to what the absence of I have heard lamented over and over again by the mercantile navy, the apprenticeship system. That apprentice system did its work. It did its work in many ways, for which we cannot now find a substitute in any sort of way. It quietly and unobtrusively prepared our boys for seamen, and our seamen for the Navy. It brought them up in habits of discipline which no seamen in the merchant service is ever subjected to, and which in the case of boys is invaluable, no matter what business they are afterwards engaged in. It gives them a power of self-denial and a power of working together, which, if not learned in boyhood, is never learned afterwards, and which, with the men we now get, who begin service at sea much later in life, we can never hope for, except perhaps with the warrant officers. I might add to that a recent instance which has come under my notice of the impolitic way in which our warrant officers are treated. For I find it has become a practice of late years with subordinate officials to ignore the legitimate claims of warrant officers. I hold in my hand a letter in which it is said it is not the custom to confirm in certain cases. Therefore, a man who had every claim to be confirmed was not confirmed, but was met with excuses all through. Instead of looking into the question, they disgusted this man, and that man may in consequence keep thousands of men away from the fleet, for every man disgusted takes his disgust with him all over the country. Thus, the system which is pursued in an office in London may be productive of infinite loss. We must at least beg that red tape may be abolished, that the foolscap may be reduced, and that however valuable statistics may be, they may yet not be held to supersede facts.

The CHAIRMAN: Any gentleman wishing to take part in the discussion by calling here ten days hence, will be furnished with a copy of the paper. The discussion is adjourned to Monday, the 25th.

ADJOURNED DISCUSSION.

Monday Evening, February 25th, 1867.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

The CHAIRMAN: As there may be some gentlemen present who have not heard the paper, and who have not had the opportunity of reading it, I may say in a few words that the subject was "Manning the Navy." The subject was divided first of all into the classes of boys, marines, stokers, and seamen. As the boys were stated to be 7,000, a number sufficient to keep up the waste of seamen, it was not necessary to discuss that point. The marines being, of course, a standing force, it was not necessary to take them into account. Then, there were 13,000 stokers and artificers, who do not enter into the discussion. The discussion, then, is limited to the fact of 22,000 seamen being, according to Mr. Reddie's estimate, the minimum force for ordinary service in peace time. In addition to that, Mr. Reddie divided that question of seamen again into a minimum force, contingent force, reserve, and war levies. The minimum force was for peace service. The contingent force was in case of little wars and warlike demonstrations. The reserve had a distinct understanding that they are not to be called out except as war levies. It is supposed that the contingent force, that you may want for a little war, or for a warlike demonstration, is to be drawn from the mercantile marine of the country. In addition to that, the war levies over and above that which is absolutely necessary—I mean over and above the amount of reserves—will also have to be drawn from the mercantile marine Mr. Reddie went on to say

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t the present Naval Reserve, defective in several points: Firstly, as .. contingent force. Secondly, as tending so far to a higher rate of .eserve are receiving a bonus, in addition to their ordinary wages, as .e, which makes the wages of the Reserve higher than the wages of the :, so far, tends to keep men out of the contingent force. Thirdly, he .at, as compared with men-of-war's men, the training was insufficient. y, he contended that they were expensive. Fifthly, it was rather .ul whether, when they are called upon, they would be forthcoming: . because the waste is so considerable. Thus, for instance, there have been 00 men enrolled in the Reserve; nearly 5,000 of them, that is 25 per cent., ..e disappeared. Well, if that were continued over ten years, it is to be gathered that the men who are now in the Reserve will all have disappeared by that time, so that if you have a Continental war at the end of ten years, the question is, where will the men be whom you have been paying. The next objection that Mr. Reddie had to the present arrangement was, that as the Reserve are now receiving a higher rate of pay than the Navy, if they were called out, they would be called out to serve for a lower rate of pay than they are receiving. Therefore, he considered that it would be indispensable, either to expect them to serve at a lower rate of pay, or else you would be obliged to raise their rate of pay, and doing so, you would be obliged to raise the pay of the whole Navy. Another question which was not dwelt upon by Mr. Reddie is a very important one. It is one that is stated in the tables that he has laid before the meeting. It is this, that in 1813 you had 147,000 seamen, all told. At that time there were only 167,000 in the mercantile marine from which to draw your levies, or to obtain any increase that you might want. At the present time your total numbers are 69,000 seamen, and 350,000 men of the mercantile marine to draw from. And that does not represent the whole, inasmuch as these numbers only represent those in registered vessels. The question, of course, suggested is: If you did without a Reserve in those days when you were under such disabilities from the small number of men in the mercantile marine, is it necessary to have a Reserve now? These are questions for you to discuss. And as they are so important, if gentlemen would kindly refrain from entering upon collateral questions of comparatively little importance, it would tend very much towards getting a verdict upon these important points.

Mr. REDDIE: Before proceeding to the discussion, I should like to make a slight explanation as regards this statistical table. I am indebted to my friend Captain Heath, R.N., for pointing out one inaccuracy in it,* which arose from my sending it to the press hurriedly. The title of the second column from the end, showing the numbers actually serving in the Navy should not be "Borne in H.M. ships," but "Actually serving," as it includes the marines on shore. It includes 8,000 in round numbers of marines on shore. With reference to your interesting *précis* of the issues, I only venture to say that you have gone slightly beyond me on the points that I brought forward. For instance, about the waste in the Reserve, I must appeal to my paper.

The CHAIRMAN: I must say Mr. Reddie did not state what I have said. I have overstated it. It is matter of fact what I have stated to you, that 21,000 men were enrolled in the Reserve, and 5,000 have disappeared; if I remember, 1,500 by death. About an equal number have not come forward to be re-enrolled.

Rear-Admiral A. P. RYDER: I am sure we must all be exceedingly indebted to Mr. Reddie for his kindness in coming down and reading a paper, which took a long time to read, and which must have taken him much longer time to prepare, and also for the tables which he has drawn up, and which are exhibited on the upper curtain. But I think we owe a debt of gratitude to other persons besides Mr. Reddie. We owe a debt of gratitude to the Lords of the Admiralty for,—I will not say sending Mr. Reddie here to instruct us on this point,—but for allowing Mr. Reddie to come down and to bring with him all these statistics. I have no doubt he has brought down with him everything that he thought would be interesting, or that would bear upon the question. I think we really do owe a debt of gratitude to any Public

* See folding table, Appendix A, Table 1, now corrected.—ED.

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Department that allows such important questions as these to be brought forward by its Officers. I feel specially grateful to the Admiralty for allowing it, because it is a question that I have been working at for the last four years, and I have always felt myself to a certain extent tied down in the matter, because I obtained my statistics from a public board while I was on full pay, and had opportunities of getting them; therefore I have never felt myself free until now to speak publicly on the question, or to take any public notice of it. Mr. Reddie having come down with the permission of the Admiralty, I now feel perfectly free to say everything I know on the point, and to make what suggestions appear to me to be best. I may premise that with the exception of the latter part of Mr. Reddie's paper, in which he speaks, if I remember aright, of apprenticeship in the merchant service, and of the advisability of having training ships there, and in which I perfectly agree with him,—with that exception, and I am afraid it is almost the only part in which I do agree with him,—I differ very widely from him in other parts. I think in a discussion of this kind, where you must take so very much for granted, both from Mr. Reddie and from myself, it is well that those gentlemen who are present, who probably have never heard my name before in their lives, and possibly never heard Mr. Reddie's name, that they should know very shortly what are the qualifications that we possess to enable us to discuss this point. Mr. Reddie is, as he told us in his paper, and as we know, an Officer in Somerset House, a civil Officer connected with the Navy. I think he said, I am trusting to my memory now, that he had been twenty-seven years in that department. Therefore he is a public Officer of great experience, and he has risen to be the head of one of the three great Departments of Somerset House. Of course, everything that falls from him on a question of this kind is entitled to our confidence. I should tell you that in my case I commanded the Coast Guard and the Reserves for three years, up to about nine months ago. From the time I had command of that force, I took, as it was right I should do, a very great interest in everything connected with the Reserve, and everything connected with the waste of seamen, and with the supply of boys, because the arrangements for the supply of boys was to a great extent carried out by Coast Guard officers. The Coast Guard were ordered to recruit boys, and therefore the whole question passed to a great extent through my hands. I determined to master the subject, and I think I did so; and I was in constant communication with the Admiralty on the point. When questions of this kind are brought before you, and, as I have said, you are to take a great deal for granted from each person who discusses it, you ought to know their antecedents connected with the questions brought before them. Mr. Reddie, coming from the Accountant-General's Office, of course comes here with great experience as an accountant; and unless we know to the contrary, I think the impression given to all persons listening to him and to his paper will be (not that he intentionally gives that impression himself), and I have no doubt he will rise and deny it, but the impression which will necessarily be given to all persons who go away from here having heard his paper, will be that he gives the opinion of Somerset House; that he gives the opinion more or less of the Accountant-General of the Navy. Mr. Reddie will of course deny that, and say, "I am merely giving Mr. Reddie's opinion." But I think he will agree with me, that that is the impression that may be taken away from this room.

Mr. REDDIE: Mr. Chairman, Will you allow me to rise to order? Admiral Ryder knows that when the question of discussing this subject in this Institution was mooted, I was most anxious that *he* should read a paper himself. The Accountant-General of the Navy never communicated with me, nor I with him, upon this subject. I speak here for myself, and I rely upon the merits of what I have brought forward. Having been requested by the Council of this Institution to read a paper, and having asked the permission of the Lords of the Admiralty to read it (not one of the Lords of the Admiralty knowing in the least what I should say), I have done so; and Admiral Ryder knows all this to be the fact.

The CHAIRMAN: It was proposed to me to contradict a statement, that has been made that Mr. Reddie was put forward by the Admiralty. I did feel that such an anonymous statement ought not to be taken notice of. And I have no right as Chairman here to allow such an imputation to be made on the Admiralty that they had any intention either improper, or what really from the style of the remarks would imply,

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dishonest. Therefore I did not take notice of it. I said to the Secretary, the proper course to adopt was, that any gentleman, who had the impression that the Admiralty had any intention in putting Mr. Reddie forward, should ask a straightforward question on that point, and he would get a straightforward answer. To act otherwise is to prejudge the whole question. I have consulted Sir John Hay upon the subject, and I am authorised to state that the Admiralty permitted Mr. Reddie to give the lecture, but that they are in no way pledged to his views.

Admiral RYDER: What I was about to say was this: I repeat it, although this explanation may make some difference in the matter; but for the explanation, persons leaving this room would inevitably consider it highly probable that Mr. Reddie's paper, *minus* his explanation and denial, would carry with it the weight of the Accountant-General. They would not be able to say positively, but they would not know, that it did not, and they would think it highly probable that the Accountant-General agreed with him, as it is not unnatural that the two chief Officers in a Department like that, should agree. What I am going to say is this, that without breaking any confidence in the matter I can assert that the opinions of the Accountant-General given in official letters which came under my eye, and which I now feel myself free to allude to, were distinctly at issue with Mr. Reddie's opinion, as stated in his paper. (Mr. REDDIE: At issue? Admiral RYDER: At issue. Mr. REDDIE: Then I do not represent his views.)

Admiral RYDER: You will have abundant opportunity of reply. I say, when statements of the kind which I have drawn up, representing the views which I am about to bring before you, were sent to the Accountant-General to report upon, his report was this, that he went further than I did in his estimate of the great falling off in the number of seamen, and the very insufficient supply of boys, and the disastrous effects it was likely to have upon the Navy. I think that is a perfectly proper thing, and germane to the point for me to state. And I state it that I may destroy any *prestige* which may accompany Mr. Reddie's paper, and which, as I have said, might probably be the case, if people left this room without the explanation I have given. There is another *prestige* which Mr. Reddie may have, and that is this. I believe the Navy Estimates were printed two or three days ago. Perhaps, Mr. Reddie will kindly tell us how many less men were voted, and how many more boys, if it is no secret. Can you? I won't ask you if you would rather not state it.

Mr. REDDIE: I can only say that when I read my paper here, I had not seen the estimates. The Navy Estimates were not then published.

Admiral RYDER: Can you tell me, as a fact, how many more boys are to be voted?

Mr. REDDIE: I have now got the estimates here. There are a few hundred more boys.

Captain HEATH: The difference is trifling,

Mr. REDDIE: I thought we were discussing my paper, not the Navy Estimates, nor the Accountant-General's department.

Admiral RYDER: Not the Accountant-General's department. We are discussing your paper. It is perfectly open to Mr. Reddie, perfectly right for him when he gets up in reply to say, "Admiral Ryder and I differ widely as to the number of boys that ought to be sent into the Navy every year." But you, gentlemen, who will go away not able to master the subject entirely, and who are taking a great deal on credit from both of us, when you look at the estimates for this year, will see what the Admiralty propose to vote this year, and you may say, "They have not "taken Admiral Ryder's views, which it is said he has been pushing forward so long, "but they have taken Mr. Reddie's views. They are only taking a few more boys "than last year, and they are taking some few less seamen." Now, I do not intend you to leave this room supporting Mr. Reddie's views. I know from some experience at the Admiralty, extending over three or four years, that anybody who draws the conclusion that because estimates are taken for a certain number of men or boys, that that represents the real views of my Lords on the point, *will make a grievous mistake*. My Lords' estimates, after they have made them, are constantly altered, from having to deal with the Treasury. They are altered and cut down, after their own opinions are fully expressed. Therefore, if Mr. Reddie uses this argument, I leave you to attach what weight to it you like. I attach none! Having

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made these remarks, I now come to the question of the paper. Mr. Reddie's paper may be divided. He gives a very great deal of interesting information about the votes in the last French war, and so forth. But the principal part of his paper was connected with the Reserve, the waste of seamen, and the supply of boys. Now with regard to the question of the Reserve, having commanded it for three years, I should like to make a few observations to you, as to what I think of the Reserve, and what value I attach to it. You are aware that it numbers about 16,000 men. You may see two diagrams on the wall. Diagram 2, Appendix B, represents the addition every month to the Reserve, beginning from the month in which it first started, and coming down to this month. Diagram 1, Appendix B, gives you the months all added together. So that you can see by the different lines drawn upon it how the Reserve has varied, and the number it has reached. An interesting fact will be pointed out to you in the upper diagram (2), which I shall allude to presently. I have visited the seaports where these men are drilled; I have visited the batteries along the coast where they are drilled; and I believe them to be a thoroughly valuable body of seamen. I believe that they are orderly; the punishment among them is ridiculously small. When you consider there are about 16,000 men in the force, and always on an average about 1,400 under drill, I think the punishments are ridiculously small. They were zealous in doing what they were told to do. I have often asked Officers to go down with me, or without me, to the "President" in the West India Docks, to see how these Reserve men drilled. On one occasion I took Captain Ewart of the "Cambridge," an experienced gunnery officer, and asked him to see these men at drill. He was delighted with the way in which they worked, and the knowledge they showed of the gun-drill, the musketry-drill, and the cutlass-drill. I believe that the Force is the most economical Reserve that we could have. When you consider the number of Officers which I will mention presently, and the number of men in it, and the necessity, which Mr. Reddie has entirely overlooked, *that all Reserves must have their periodical drill*, I think I am right in saying he has overlooked it, because he takes credit in his proposed Reserve for a great economy on the score of their not having any periodical drill. Of course, Mr. Reddie, sitting in his chair at Somerset House, does not enter into this kind of question, as to what drill these men require. I dare say he looked at it from an accountant's point of view, and thought that what was called a drilled man would want no more drill, just as if a man who had had his dinner would want no more dinner. We differ in that respect. That is my opinion of the Reserve. Now, the next question is, what Mr. Reddie proposes to do with the Reserve. I think I am not wrong in saying that there were two statements which he has made with regard to the Reserve. I call the first, "Mr. Reddie's suggestion to the Reserve." I have no doubt Mr. Reddie will say, "I never intended to make any such suggestion to the Reserve." I am willing to believe that he did not. It only shows that people should consider carefully what meaning may be put, and very easily put, upon their words, before they use them. I now read it:—"If these men are backward in coming "forward to fulfil their agreement under these conditions, it may be a question whether "they will be held to their agreement." I say that that will be understood to be a suggestion, not intentional, of course, on Mr. Reddie's part, but a suggestion to the Reserve, that when they are called out, if they are backward in coming forward, they will stand a very good chance of not being held to their agreement; which by the context, if you look at Mr. Reddie's papers, means that when their services are required, if they are only "*backward in coming forward*," they will probably be induced to come by a promise to give them their retainer (£6 per annum) afloat. I do not command the Reserve now; therefore, perhaps other people who belong to it, and who are in this room, might speak more properly in their name than I can. But if I did belong to the Reserve I would repudiate the suggestion in the strongest possible manner. The men who belong to the Reserve are, I believe, as honest, patriotic, and loyal as any other body of Englishmen. I think they will not thank Mr. Reddie for his suggestion. Mr. Reddie goes on to make what I call his "threat "to the Reserve." He says, "if the Reserve impedes the manning of the Royal "Navy, and if the Naval Reserve places the merchant seamen who enter it at a great "advantage compared with the seamen who are actually doing us service in Her Ma-

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"jesty's ships, then it might be the duty of Parliament and of Government, even, to "abolish the Reserve altogether; or, at any rate, that any fresh or more equitable "terms which might be deemed advantageous for the interests of the country, might "fairly be offered even to the men now enrolled, leaving them, of course, quite free to "quit the Reserve, or to continue in it on the new terms at their option." Now, as I understand that, and we know various meanings may be given to the same words, it means but one thing; and that is, that in Mr. Reddie's opinion the Reserves have got too good terms; and that, under certain circumstances, if such and such things in the beginning of the sentence are considered to have taken place, then this option shall be given to the men of the Reserve; not, mind you, that they are either to leave the Reserve or to take the new terms, or to remain during the term of their natural lives, or during the term they are at all available for the Reserve on the conditions they have now, which latter would have been a perfectly fair offer, and a right thing for Mr. Reddie to say. I think you will see I am not going beyond the mark at all in stating that what Mr. Reddie says is a very different thing, indeed. He thinks the Reserve have had *too good* terms. He suggests that under certain circumstances, they should have *worse* terms offered them; and he suggests that if they won't take them they shall quit the Reserve. Now, I call that a threat. I perfectly agree with the Chairman in the conversation he had with me before the meeting, that he did not for one moment suppose the Lords of the Admiralty are in the slightest degree a party either to the suggestion or to the threat. And nobody holds that opinion more strongly than I do. But I say, as I said before, that Mr. Reddie's coming down here from Somerset House and making use of these statements, will lead, and has led, to misconception. For there are gentlemen in this room who will tell you of letters received from the different seaports. I have myself seen newspaper leading articles upon the point; they all go at once to this:—"What are the Admiralty "about to do? Surely this is a feeler. Mr. Reddie has been sent down to this "Institution in London to throw out a feeler on this point, 'that their Lordships "are about to destroy the Reserve, or to give them the option of taking new and worse "terms, or leave the force.'" Of course, Mr. Reddie is not speaking for the Admiralty, and he is not speaking for Somerset House; he is only speaking for himself in the matter. I think that that should be known thoroughly in all the seaports; and I hope their Lordships, in their wisdom, will take such steps as may seem to them necessary to remove this impression which has got abroad. I have written certain statements (pointing to those on the walls), and I have used the word "we," which is not an uncommon word to use instead of the word "I." I do not think anybody need take objection to the word "we." We do not in this Institution bind any one to anything that is said; we do not bind the meeting. The Chairman will not get up and ask you to hold up your hands one way or the other. He will get up, perhaps, and "sum up;" but the Chairman's summing up does not bind the meeting. What I have put down in these statements is what I think myself, just as what Mr. Reddie says, is what he thinks. Mr. Reddie comes down here hoping to win the approval of those who hear him, and that they will go out of the room concurring with what he has said. I hope so, too; as to what I am going to say, I hope those here who listen to me, or the majority of them, will agree with me in the matter. This is the way I would sum up what I think about the Reserve:—"Although the existing Royal Naval Reserve may be improvable in various matters "of detail, it is deserving of our confidence and that of the country, because it exists "in reality, and not merely on paper (which is the position of Mr. Reddie's Reserve), "because it is composed of 16,000 British seamen, of whom about half are always in "Great Britain, and the rest return at the rate of about 1,000 per month." There are two gentlemen in this room, Mr. Gray, the Marine Secretary of the Board of Trade, and Mr. Mayo, Registrar-General of Seamen; they are both thoroughly up in this matter, and I hope they will make a few remarks after I have finished, and confirm my statement, or point out where I am wrong. Then, I say:—"Because we "believe that the men are carefully selected, are orderly, contented, zealous, patriotic, "well disposed towards the Royal Navy, and that they will strictly fulfil their engage-"ments, and will not be backward in coming forward, notwithstanding any suggestions

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" to the contrary that may be made to them from whatever quarter." I have used the word " patriotic;" and I said I would refer you presently to that upper diagram (2), and I will do it now to illustrate that point. When the news came to England in November, 1861, of the outrage on board the "Trent," the Naval Reserve had been in existence about two years. As soon as the news was well promulgated round the ports, what did the merchant seamen do? Those who abuse the Naval Reserve—and I am sorry to say there are some among my brother Officers who have called it a myth—I say those gentlemen, if they were consistent, would naturally expect that, when news of that kind came, the entries into the Naval Reserve would rather fall off than otherwise. It would be natural to think so if the Reserve was merely taken up just to make a little money at the time without any real intention of coming forward. But what did happen? In four months following 3,500 men entered. I think you can see from all parts of the room those long black lines in the upper diagram, stretching across the paper, the longest one represents 1,000 men. The space between those up and down black lines are 100's. Those four long lines which are the longest lines on the sheet, represent the entries, and which came in after the outrage on board the "Trent," represent, in fact, 3,500 men—one-fourth of the whole Reserve. Now, I say that shows a thoroughly good feeling on the part of the men in the merchant navy. There are 20,000 foreigners, I am sorry to say, in the merchant navy, and it is not likely that there are any of these in the Reserve. There are also in the merchant navy, men of indifferent character—men who are troublesome fellows; they are not in the Reserve. But the better class of merchant seamen are, I believe, thoroughly patriotic, and would come forward to join the Reserve if anything of the kind takes place again. One Officer in particular, and I know his case is not an uncommon one among persons who have not studied the subject, said to me, " A gentleman went down to Hull at this particular time, " when the 'Trent' business took place, and called a meeting of the Naval Reserve. " I do not know if he was authorised to go down or not, but he asked them all to " come forward and put down their names, to join the Royal Navy, and not one " came forward." "That," he said, " showed a want of patriotism on the part of the " Naval Reserve." I contend it showed nothing of the kind. These men entered into a solemn engagement, which they do not regard lightly at all, to hold themselves in readiness to be called out whenever an emergency takes place, and war is threatened; and why should they break that engagement and come forward and enter the Navy? There they were *en bloc* ready for service. I contend it was no test at all of loyalty. The test of loyalty was on the part of their brethren and relatives, merchant seamen, who came into the Reserve at that moment, showing that they were perfectly ready to be called out when wanted. Then I proceed to say:—Because we believe the assertion that they are well drilled and are as expert in the various gunnery exercises as circumstances will admit. I allow that you must take this opinion for what it is worth, it is my experience for three years constantly visiting drill ships and batteries. Because we believe the assertion of the Duke of Somerset, in the pamphlet Mr. Reddie so often quoted, " That the " creation of the Royal Naval Reserve has brought the mercantile marine into close " connection with the Royal Navy, and has tended to remove prejudices which in " former years seriously interfered with the manning of our fleet," as for instance, in the Russian war. And again, " we have no confidence in Mr. Reddie's proposal " for a Reserve." We do not believe that any sufficient number of men-of-war's men will be forthcoming to form his Reserve, or that they will accept his terms and conditions, or that his Reserve will be "economical." Now, we have in the existing Reserve a great fact. But in proposing a new Reserve, its value must be a question of opinion. It is Mr. Reddie's opinion that he would form, he would not say how large a Reserve, but that he would form a Reserve. I have thought over it a great deal, and I have had some experience in the matter from commanding the Reserve. I have talked it over with persons who have had the same experience, and I do not see any prospect of any number of men being available for Mr. Reddie's Reserve. They are leaving the Navy very quickly already. I do not think Mr. Reddie's terms are very tempting. He does not propose to give them any drill pay or subsistence money, for he does not think they want any drill, and he cuts off thus three shillings a-day

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for a month at once, and he proposes a most onerous addition to the conditions, viz., that "they shall be called out whenever they are wanted,—and not only in case of "emergency." Whenever there are wanted, say 100 men, the Admiralty will have to send down to Liverpool or Dundee, and will put their hands on these 100 men. Or, supposing two or three hundred men are wanted to commission a couple of frigates, the same course will be adopted. It sounds a very odd way of managing it, but somehow or other he would attempt this way of getting these two or three hundred men out of his Reserve. I do not think his Reserve will be formed. I do not believe the men will accept his conditions. Then, I add:—Every Naval Reserve, whether composed of merchant seamen or of men-of-war's men, must have at the least one month's drill every year. We are of opinion, that under these circumstances the existing Royal Naval Reserve, which costs about £200,000, which secures the services of 114 lieutenants, 80 sub-lieutenants, and 16,000 seamen, is a most economical force. I do not believe—it is matter of opinion again—that you will get anything like so valuable a force for the money in any other way. Then:—Finally, we deeply regret that statements made in the paper that has been read in this Institution should have given rise to the belief that the Admiralty are contemplating the "abolition of the "Reserve altogether," and that this is to be done by giving the men in the Reserve the "option of accepting new terms more advantageous to the interests of the "country, or quitting the Reserve." I have already spoken to that point, and I will not repeat what I have said, but I proceed:—As this paper was read by a gentleman holding a very high position in one of the Civil Departments of the Royal Navy, it is much to be desired that the proper steps be taken to remove this impression, as in our opinion the forcing of the above-named option would be breaking faith with the men now in the Reserve, and could be justified by nothing short of national bankruptcy. That is my opinion, and I have given you my reasons for holding it. I have now said all I wish to say about the Royal Naval Reserve. We now come to the question of the waste of seamen, and I may tell you here that these Tables I and II, Appendix B, which are made in a different way, and put together, I may say in a different way to a certain extent from Mr. Reddie's, all either come from the Admiralty or from Somerset House, or they have been checked at Somerset House, having been sent there for the purpose. There is an exception, perhaps, in one or two cases in the lower line, where, of course, from only being able to get the facts lately, those lower lines in some cases cannot have received that check. In all other cases they have been carefully checked, and therefore, as far as the statistics go, I stand on the same ground as Mr. Reddie himself. With regard to Table I, Appendix B, you will see if you can read the heading, that that is arranged to show the loss or gain of continuous service men, and of non-continuous seamen, every month from the 1st of March, 1864, to October, 1866. I should like you carefully to look at that table, and you will see the way in which continuous service men are pouring out of the service, and the non-continuous service seamen, the same. If you look under column two, you will see the decrease each month of the continuous service seamen, and under column five you will see the decrease of the non-continuous service seamen; and in the other columns, three and six, you will see the increase. At the bottom you see the summing up and total balance. You will see that in the thirty-two months, included in that table, there was a reduction in the number of continuous service men of 1,834, viz., decrease, 2,661; increase 827; making altogether a diminution in the number of continuous service men of 1,834. In the same way we find there has been a reduction of 1,295 non-continuous service men, making a total reduction of 3,139 *bonâ fide* seamen. During the same time, about 4,000 boys were rated seamen. This is what you must bear in mind, that when we find a large decrease of seamen going on, you must ascertain not how many seamen have really left the service, but what has been our real loss. You must always therefore add the number of boys that have been rated seamen during the time, to the diminution that has taken place in the number of *bonâ fide* seamen. The number, therefore, that represents the waste of seamen, as it is called, amounted in those thirty-two months to 7,139 men, continuous and non-continuous service men, and that if you divide—

The CHAIRMAN: Why do you add boys?

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Admiral RYDER: If boys are rated men, they step into the vacancies of seamen that are gone. You will find 12·7 per cent. has been the waste of seamen during those 32 months. Now Mr. Reddie estimates the waste of seamen, as you see in his pamphlet, at 10 per cent., and he arrives at that, by means which I will explain to you in one of the tables which I shall show you presently. I differ with him and call it 12·7 per cent.

The CHAIRMAN: Per annum?

Admiral RYDER: Yes.

The CHAIRMAN: Not every 32 months?

Admiral RYDER: No, per annum. In estimating the waste that has taken place, and being desirous of making your arrangements for recruiting the waste for the future, you must of course not omit any sort of waste that you feel certain is likely to arise immediately. Now with regard to the Coast Guard, with which I am familiar, this is its position. The Coast Guard was under the Custom-house up to the time of the Russian war. After the Russian war it was placed under the Admiralty, and they found so many old men in the force that they sent round the then controller, Commodore Eden, who cut the force in two, and placed the younger men on what was called the fleet list, and the older men were called civilians, and placed, so to speak, on one side. We have since been recruiting the fleet list by young men, but of course the force being ten or twelve years older, we are gradually increasing the mean age of that force year by year; and they are just now beginning to pour out, if I may use the expression, owing to their having now become an older force again. Now I carefully estimated the probable drain on the Coast Guard force, and this must be replaced from seamen afloat. The waste of 12·7 refers only to what has taken place as regards the seamen afloat; by my estimate about 380 men would be required annually for the Coast Guard ashore from the service afloat to recruit them, which amounts to 1·8 per cent. on 21,000 men afloat. And therefore, by adding those two together, that is to say, the existing waste which has been taking place for the last 32 months, to this waste which is just beginning to take place, because remember, when we enter boys to-day, it is to make seamen three years hence—adding, I say, that 1·8 per cent. to 12·7, you get what I consider to be the real waste that we have got to allow for, which is over 14 per cent. If anybody chooses to take the trouble to follow my steps when they get that table when printed in the Journal, they will find a very curious result. They may measure the strength of that stream, if I may so call it, at different parts, and they will find, to use Mr. Reddie's expression, a curious persistency in the way the drain runs. If they take it in the middle, at either end, altogether, or straight through, they won't find any very material difference in the rate at which the men are streaming out of the Navy. I have taken it there from May to April—twelve months, that is to say, the financial year, 1865-66, and it is 12·7 per cent. I have taken it (because some people have said "You must not go so far back") for the last six months, from April to October, and I find it comes to 13·5 per cent., varying never more than one per cent., and therefore I assert that the waste for which we should estimate is, at least, 14 per cent., and not 10, as Mr. Reddie stated it. Mr. Reddie's answer to that is this (I think I shall not misrepresent him in saying that this is the answer, for he has given it to me before), "What we calculate at Somerset House "when we are told to state to the Admiralty what has been the waste is this, we only "take into account the '*casualty* waste,' which waste arises from, I think, 13, 14, or at "all events, a very large number of different sources—streams, so to speak, that are "running out of the service, viz., invaliding, death, discharge to sick quarters on the "shore, desertion, discharge with disgrace, discharge as objectionable, by purchase, "on pension, from order, on request, for incompetency, and discharge of continuous "seamen refusing to renew their engagement on shore." These, I believe, they call at Somerset House the casualty waste, and they—he is perfectly right there—amount to about 9·5 or 10 per cent. "But," says Mr. Reddie, "*you* have taken into account the paying off waste." That is to say, the number of non-continuous service men who have left the service on paying off and have not come back again. "I," he says, "took no account of that. That results from the action of the "Admiralty, and you need have nothing to do with it. The Government choose to

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"take a lower estimate for the year; the Admiralty, obliged to follow suit, must pay "off more ships than they would otherwise do, and, as is the fact, the Admiralty "issued an order that no ship in the home ports should enter any men from the "shore. And therefore," Mr. Reddie says, very naturally, "the Administration "squeezed these men out of the service. It was not the men's fault; they would "have come back if they could do so, but the Admiralty did not allow them—would "not admit them on board." But it so happens, and this fact Mr. Reddie was not aware of, for he told me when I mentioned it to him, that he had never heard of it before; it so happens that when the Admiralty gave that order with regard to the home ports, they sent for me then, or shortly afterwards, as I was commanding ten or eleven large ships situated near to the home ports—one situated near Portsmouth, one near Plymouth, one close to Sheerness, and others round the coast, near where the seamen go to their homes, and told me to enter them as fast as I could, and report the entries periodically. And therefore I say that this squeezing men out of the service did not exist. The men were perfectly free to have come back into the service if they liked to do so, because there were always a number of vacancies in the Coast Guard ships (seven hundred was the aggregate number), for as fast as the men had served one or two years in Coast Guard ships, they were drafted into sea-going ships, so that there were always a number of vacancies created, and we tried all we could to get these paid-off men to join. As a general rule they did not choose to join, they did not wish to join, and therefore the loss on paying off, as I maintain, in opposition to what Mr. Reddie says, is a waste that ought to be allowed for. In the first place, I do not know what his view may be now, but when he did not know the fact of the order having been issued, he held the view that this ought not to be accounted waste. Now I maintain, as the men could always have come back if they liked, it is a legitimate waste, and runs up the total to 14 per cent.

The CHAIRMAN: Do not other men come in to supply their places?

Admiral RYDER: If you take the numbers from the top to the bottom, you may say of John Smith "How do we know John Smith did not come back, but that is "no proof." Compare the numbers, you find, the numbers for 32 months, there are about 7,000 men gone, or 12·7 per cent. of 21,000 men per annum, partially replaced by 4,000 young seamen rated from boys, but the uncompensated waste is 3,200.

The CHAIRMAN: Do you mean to say the number of men actually serving is less each consecutive year?

Admiral RYDER: Yes. Look at the table. That is checked from Somerset House. That is the drain going out.

Mr. REDDIE: Part of these figures are our statistics; not all. You have given the men that went out, but you have not given the men that the Chairman speaks of as entering.

Admiral RYDER: I say the difference between the gross number at the top and the gross number at the bottom includes all entries and re-entries.

Mr. REDDIE: But we were reducing the votes.

Admiral RYDER: I say if every one of the men might have come back and did not, *then the loss does not arise from the reduction of the votes.*

The CHAIRMAN: Suppose the House had reduced it by 10,000, would you call that 10,000 waste?

Admiral RYDER: If there was an opportunity for the men to come back whenever they liked, and they did not avail themselves of it, your argument falls to the ground, that the men were reduced by the action of the vote. I am sure if you think over that you will see it. In Table II, Appendix B, which is also checked at Somerset House, you will see by looking at the columns, the points that Mr. Reddie has been speaking about—you will see the number of seamen who have left. You will see in column 6 the number of seamen who have entered and re-entered; while column 7 gives the difference between the entries showing the actual waste.

In column 8 you get the number of young seamen rated from boys; deducting that from the other you get the uncompensated waste, the actual loss all through, down to the latest statistics. As some people like to consider these statistics in percentages, I have arranged in Table III, Appendix B, the waste, &c., in percentage of the number of *bonâ fide* seamen who were in the service on the 1st of April each year,

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and of course the percentages are derived from and correspond with the figures. If you choose to investigate it you will find that the percentages are reduced from those figures in columns 5, 6, 7, 8, and 9. I make this statement, and this is where Mr. Reddie and I differ so widely, I say, "The number of boys rated seamen "annually, the number of boys entered in the training ships annually, the training "ship accommodation, and the complement of boys in sea-going ships require to be "about double what they were in 1865–66. The number of seamen rated from "boys should be about 3,000, whereas only 1,470 were rated in 1865–66. The "number of boys entered annually in the training ships should be about 4,220, "while only 2,200 were entered in 1865–66. The training ship accommodation "should be about 5,900, while less than 3,000 was the accommodation in 1865–66. "The complement of boys in sea-going ships should be about one boy to four *bonâ "fide* seamen; it was only one boy to seven *bonâ fide* seamen in 1865–66."

Those are the statements that I make and I am prepared to prove them. In Table IV, Appendix B, I have arranged the whole boy question. You will see "The annual supply of boys to replace the absolute *bonâ fide* seamen." "Number of years" in the first column, then the boys voted afloat and in training ships, then you see the boys in the service on the 1st of April, and you see the boys entered in the training ships each year, then the boys who leave the training ships for sea-going ships. The waste is about 14 per cent. while they are in the training ships. They remain 15 months in the training ships. These little cross lines give a rough idea of how many boys actually leave the training ships compared with those who join. If the first class boys are rated seamen after two years, which I think Mr. Reddie will agree is about the time we have supposed they are, the waste of boys in sea-going ships is 7 per cent. You may get confused if you do not look carefully into these percentages. The waste of boys while they are in training ships is about 14 per cent. In the last year it was a little over 13 per cent. The head of the training ship establishment estimates them at 14 per cent. The waste of boys after they get to sea having passed through the sieve of the training ship dwindle down to 7 per cent., but taking both together it is about 9 per cent. on the whole number of boys in both training and sea-going ships. In Table V, Appendix B, I place in juxta-position the number of boys entered in each year, and the number of boys rated men each year, with the same lines to show the probable loss. We allow three years from the time they enter,—one year in the training ship, and two years afloat. It is very important to estimate what the waste of boys is, and I have carefully endeavoured to ascertain it from that table. It is well not to rely too much upon what may have taken place in the year immediately preceding the year which we are at present in, because we are likely to be led astray—we ought to spread our researches over at all events a certain number of years back, and as long as there are no extraneous circumstances, evidently showing us that we must reject certain years. I treat Table V in that way as far as regards boys. (It is a very different question from that of the seamen.) We may extend our researches as regards the boys, rather farther back, and we shall find that about 29 per cent. of every hundred boys who enter the training ships are wasted before they are rated men in sea-going ships. There is no material difference between Mr. Reddie's estimates of the waste of boys and mine. Mr. Reddie's estimate is 10 per cent., but he says he considered it considerably under 10 per cent.; well, my estimate, 29 per cent., for about three years, of course is about 10 per cent. per annum.

The supply of boys to replace the waste of seamen. Now here is where Mr. Reddie and I are at issue. Everything depends upon the way the number of boys are calculated to fill up the waste. I will give you, and I think correctly, Mr. Reddie's method.

Mr. REDDIE: I may say, to save waste of time, that I did not go into those statistics, which I think relate more to Admiralty management than to the general question.

Admiral RYDER: I consider it to be of the *greatest importance*. If only half the proper number of boys are entered, I think everybody will agree it is a question of the greatest importance. Mr. Reddie's method of estimating the waste is this, he says, the number of seamen being 22,000, the waste that we are endeavouring to

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recruit for will be 10 per cent., to be replaced annually, or 2,200. The number of boys voted last year was 7,330; take off 10 per cent. from that, and you will have 6,600. Divide 6,600 by three, and you will have 2,200, and therefore he says the number of boys now voted will supply the waste. Mr. Reddie does not tell us how many boys we ought to enter this year. I do not see that stated by him anywhere.

The number of boys which we ought to enter this year to supply the recognized waste ought to be stated by him, and there, it seems to me, he is in error. I believe the correct method of calculating the supply of boys is this, and I do it, first taking what I consider to be Mr. Reddie's incorrect data as to the waste of 10 instead of 14 per cent. of seamen we ought to provide for. The number of seamen to be maintained, taking his own figures, is 22,000, and the waste to be replaced annually at 10 per cent. is 2,200.

Now, the following is, I think, the simple and correct way of solving the problem. If boys grow into men in three years, and diminish by 10 per cent. in number, in each of those three years, how many boys must be entered in 1867, to produce 2,200 young seamen in 1870? I think that is the fair straightforward way of putting it. A very simple calculation will show that 3,018 boys entered in 1867 will diminish to 2,716 in 1868, to 2,444 in 1869, and to 2,200, the number we wish to get at, in 1870. Therefore, even if we adopt Mr. Reddie's to my mind incorrect and insufficient data as to the waste, we ought to enter 3,018 boys this year, or 739 more than we entered last year. I will now take what I believe to be the correct data, and we shall then find out the number of boys we ought to enter. I substitute 14 per cent. for Mr. Reddie's 10, and get as the result, by the same process, that we ought to enter 4,220 boys this year to meet the waste which I believe to have taken place, and to meet that of course three years hence, for that is the time it takes for boys to grow into men.

The calculation is made as follows: the method is correct, and the data as to waste are accurate; while Mr. Reddie's method, in my opinion, is incorrect, and his data inaccurate.

I estimate the number of *bond fide* seamen which we are aiming at maintaining is 21,000. This was the number voted in April, 1866, when the Secretary of the Admiralty stated in his place in the House of Commons that that number *must be maintained*—a statement confirmed since in the pamphlet referred to by Mr. Reddie, and attributed to the Duke of Somerset. I do not care to strengthen my argument by adopting Mr. Reddie's larger number of 22,000. I have estimated that the annual waste of *bond fide* seamen for which we should provide, is 14 per cent., instead of 10 per cent. Now 14 per cent. of 21,000 is 2,940, or 3,000 in round numbers.

I believe that the annual waste of boys is rather less than the percentage given by Mr. Reddie, more nearly 9 per cent. of the whole number in the service than 10 per cent., but that the boys retain the rating of boy for rather more than three years (including the time they are in the training ships). But the waste of boys per annum, and the time boys retain that rating, are immaterial, provided we estimate approximately what has been and is likely to be the average waste of boys during the whole time they are boys. My table enables this to be done, and 29 per cent. is the result (not very different from Mr. Reddie's estimate of 30 per cent. for three years).

The number which, when reduced by 29 per cent. will be 3,000, is 4,220, and this is the number of boys that ought to be entered this year.

Having arrived at that figure, I will go to a very important point, the accommodation for boys in training ships. The boys remain in the training ships for about 15 months, and therefore you require of course considerably more space to hold the boys that you enter every year. You must have one-fourth more. You must have space for 5,380 boys. It is also found quite impossible to keep the training ships always full, because you are constantly drafting boys away, and of course vacancies remain, I have estimated from my experience that the training ship accommodation ought to be about 10 per cent. more than the number of boys you intend to have in them, so that you may have sometimes more than the right number, to allow for your sometimes having, as you almost always will have, less than the right number. This would oblige you to have training ship accommodation for 5,918, or in round numbers, 6,000 boys. The training ship accommodation is not 3,000, but considerably

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short of it, as you may see by running down that list, the "St. Vincent," "Impregnable," "Implacable," "Ganges," "Boscawen," "The Excellent," and "Dasher," giving accommodation for only 2,870 boys, or 230 less than 3,000. The next question is, the complement of boys in sea-going ships. The present complement is about one boy to seven *bonâ fide* seamen, but if the number of boys entered annually is largely increased as proposed, viz., from 2,279, which was the number admitted in 1865-66, to 4,244, it is evident that the complement of boys in sea-going ships must be largely increased also. If the rate of waste of boys remains without much alteration, viz., 14 per cent. on the boys in the training ships, and 7 per cent. on the boys afloat, then, as about 3,000 young seamen are required to be rated from boys annually, and the boys are not likely to be rated men until they have been two years in sea-going ships, it is evident that the number of such boys will exceed 6,000, and 6,000 bears to 21,000 proportion of 1 to 3·5, but we may consider it as 1 to 4. One boy to four seamen was about the proportion carried in merchant ships, when they were obliged to carry apprentices. There is no reason why men-of-war should not carry that proportion of boys, if it is found to be necessary to do so for recruiting purposes, but the number of men must not be reduced. The "Black Prince," with a complement of 706, has 305 *bonâ fide* seamen and 46 boys. If my proposal be adopted, her complement of boys would be raised to 76. But if prompt measures are not adopted in this important matter of recruiting, the difficulties will increase rapidly, for we cannot make seamen out of landsmen, and we can make only a small percentage out of "novices" who enter at 18 and 19 years of age. In fact, we are dependent upon boys, and boys alone, to recruit our seamen, and it will take three years before these additional boys will be ordinary seamen, and five years before they will be A.B.'s, and during all these three years the present uncompensated waste will be running unchecked. Now the answer to my proposition to increase largely the entry of boys is this, and it is a plausible one, "we shall 'be choked with seamen.' If the seamen "give up deserting, give up invaliding, and I suppose you may say, give up dying, "then these numbers of boys that I propose to send in, will accumulate, and we shall "be choked with young seamen that we shall not know what to do with." Now there is a very simple way of getting rid of that difficulty, and I put it on that paper entitled the "Proposed addition to the continuous service engagement." The object being (fourthly) to facilitate the reduction of the number of men in the continuous service body of *bonâ fide* seamen, if at any time it is found to be growing too large, owing to the increased number of boys which it is proposed to admit, or to the percentage of waste diminishing in amount; to enable (secondly), the continuous service body of seamen, while it is largely increased in number by the proposed increase in the number of boys, to be at the same time a more select body composed to a much greater extent than at present of A.B.'s. Continuous service men are now discharged for many reasons; stupidity would be added. The new clause, which I propose to be added, is, "Their Lordships reserve to themselves the power to "cancel the continuous service engagement of any man who at the age of 21 has "not passed for A.B. and trained man." I do not tie myself to the age of 21 or 22, but that is the idea. This clause would act as a safety valve, and in the course of a few years the continuous service body would have been raised to the required number, and if there was any overflow it would be of the less efficient men. The machine would, in fact, become almost self-acting, provided the supply of boys is sufficiently increased and maintained. Those are the views which I have pressed on the attention of their Lordships for some time past. I sum up in these words with regard to the waste and the supply of boys. (1) In estimating the annual waste of *bonâ fide* seamen, which arises from various causes (see Table III), due allowance should be made for any loss of non-continuous service seamen that may have occurred when ships are paid off, provided that the men so lost had (as has been the case during the last three years) ample opportunity for re-entering if they had chosen to do so. In that lies the question between Mr. Reddie and myself; in that lies the question as to the amount of waste from which we are to estimate the number of boys that ought to be re-entered every year. I say, secondly, that a large increase in the annual supply of boys, probably double the number that were entered last year, or 4,200, instead of 2,200, ought to be entered, in order to maintain the number of *bonâ fide* seamen afloat at 21,000, the number voted for this

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financial year 1866-67. I have now concluded all the observations I wish to make, and I hope that in anything that I have said, I have not given offence to Mr. Reddie. Such was not my intention in the least. I thought it necessary to say what I did say, and I said it with a hope that it would do good, and not certainly with the slightest intention of giving any pain or annoyance to him. Mr. Reddie, as I said before, has kindly come down here to read a paper, and I hope no one who follows me will say anything that will give him any pain or annoyance, or which will make him disinclined to come at any future time and read us a paper on any subject, scientific or otherwise, which he may like to read to us.

Mr. THOMAS GRAY, Assistant Secretary Board of Trade: Sir, I am sure I can do no less than Admiral Ryder did when he began his remarks, and that is to thank Mr. Reddie, and I do it sincerely, for his very able, his very interesting, though somewhat lengthy paper on our Naval Reserve. I can easily understand that this paper has not received the sanction of the Admiralty, any more than the remarks that I am about to make have received the sanction of the Board of Trade. If it were so, Sir, you would behold at the present moment two Departments, as it were, squabbling over one question. Now, Sir, Departments of Her Majesty's service never differ, never squabble. I may mention, as an illustration of Mr. Reddie's present position, a paper I read last year at the Society of Arts. That was a paper that abused legislation that had thrown duties on my own Department, soundly, and I think somewhat strongly, but yet I can say for that paper the same as Mr. Reddie says of this paper, and that is, that no one, not a soul in my office, knew what I was going to say. Although I obtained the sanction of the Chief of my office to read a paper on a subject, nobody ever saw my manuscript or my paper until it was printed to be read at the Society of Arts. And I believe and hope, for the credit of the Admiralty, that the same is the case with the paper Mr. Reddie has read here. Now, Sir, I shall not go into the question of the waste of seamen, or any of those detailed questions. I feel that, interesting as they are, on an occasion like this they are perhaps somewhat dry. I must, however, under correction from the Chairman, make a few remarks on details. I do it under correction, and whenever you are ready to stop me I shall stop. I will now say that the true policy of a country like ours would be, to give to every citizen, whether ashore or afloat, a certain amount of training. But it is not the policy of a country like ours to require that every citizen should either be in the Army or in the Navy for a certain fixed period of his life. The scheme proposed by the Royal Commission of 1859 was perhaps one of the most perfect of its kind, and will illustrate my meaning perhaps as well as anything I can bring you. They proposed that, besides the standing Navy, there should be, reliefs in the home ports, 4,000 men; coast guard, 12,000; marines, 6,000; marines, short service pensioners, 5,000; seamen short service pensioners, 3,000: making a total of 30,000. That there should be a Royal Naval Reserve of 20,000, and coast volunteers, 10,000. Now this scheme, had it been carried into effect, would have placed us on a sound footing, and have been open to no question. As it is, a part of it only, and that a minor part, has been carried into effect. The Royal Commission of 1859 proposed that the permanent Reserve of seamen should be drawn entirely from boys who entered the training ships, and that, for the purpose of creating a Reserve temporarily, we should draw upon the merchant service, and that is the present Royal Naval Reserve. Here is where I take my stand. So long as Government think fit not to establish training ships for the Navy in sufficient numbers to produce our Reserves, so long are we bound to continue our present system, which is one of the best, one of the most economical, and one of the most efficient services that have yet been established in this country. But to keep myself to the point before the meeting, I will say that I have been over Mr. Reddie's paper, and, as carefully as I can, have taken out what seemed to me to be his points. The first is that the "Royal Naval Reserve rigs the market against the Royal Navy." Secondly, the cost is altogether out of proportion, and beyond the value of the force. The third is that the Royal Naval Reserve is insufficient, and is wrong in its construction. The fourth is that it should even be abolished in favour of his scheme, and he hints that the reserve men may be backwards in coming forward. Our Chairman quite endorsed these views, as he said at our last meeting—"It struck "me that Mr. Reddie was not going into detail, and going into numbers would be

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" going into detail, and leaving the principle, which is the real point, untouched. " His real argument rested on the principle of economy. If the present system " does bribe men to stay away from the Navy—if it has that effect, the present " system is indefensible. It is money thrown away; and if you cannot get men to " come even after they are in the Reserve, it is money thrown away again."

The CHAIRMAN: Very well, you will observe that I say, "If it is so"—a very material difference.

Mr. GRAY: I am very glad to find you have not endorsed that opinion. In the remarks I am about to make, I must go into details, for Mr. Reddie's scheme seems to me to be very much like the scheme of an engineer who tells you that he can put a bridge across from Dover to Calais. Now you all agree that that is a good idea, and you ask him for the details. He then says, " No, I am not going into details; " it is the grand idea, it is the principle I advocate." You say, " No, I must see " your details before I can approve your plan." Then you come to find that he is going to use a material that does not exist, except in his own imagination, and you would say, " I cannot agree to your plan, grand as it is, because your details are " wrong." Therefore I must attack Mr. Reddie on his details, and I do intend to attack them strongly, as well as on his general principles. The first question is, does the Royal Naval Reserve, as at present constituted, " rig the market against " the Navy?" Mr. Reddie says it does; but at the same time, he appears to me to give himself several flat contradictions. He says in page 3 (280) of his paper, " Ad- " mitting that much has been done, and well done, for the fleet; and that the naval " strength of the country is in such a condition of efficiency, that if it cannot be " described as quite perfect, it may be considered as very nearly so; for I believe it " may well bear comparison with what it has ever previously been in any time of " peace." He also says in page 15 (291), that notwithstanding this " rigging of the " market," as he calls it, 31,207 men actually entered the Royal Navy from the shore, and that 12,000 were pure blue jackets. We all know, down to a recent period, it was almost impossible to man our ships. They waited about in harbour for months, and they could not get men to go to sea; and yet we find that from the time this Naval Reserve is best known, your ships have never to wait for men; you have actually entered 31,207 seamen from the shore. How can he say the Reserve keeps men out of the Navy, and " rigs the market?" The contrary seems to me to be the case. As regards expense, Mr. Reddie says, at page 15 (292), " I beg leave, " therefore to remark, that *the present Reserve is a very expensive force;* and upon " reference to the report of the Manning Commission, that recommended it, it will be " seen that it was never contemplated, either by the Royal Commissioners, or by " those who advocated the establishment of the Reserve, that it would cost quite as " much as it really does." He then says, page 16 (293), " As regards the great expense " of the Reserve, the retaining fees alone of £6 a-man for 16,000 men, amount to " £96,000, or nearly £100,000 per annum, while the expense of management, of " drill ships, and drill pay is fully £100,000 more; whereas £200,000 was the total " amount estimated by the Royal Commissioners as the annual cost of a reserve of " nearly double that number."

The CHAIRMAN: Is that correct?

Mr. GRAY: He says so.

The CHAIRMAN: Did you quote it?

Mr. GRAY: I will answer it in a minute. I want to finish with Mr. Reddie's statements before I attack them. He then goes on to say, on page 18 (295):—" And " therefore it is important to consider how much we must pay our reserve during " every decade of peace at the present rate. In another ten years it will cost us— " that is if its annual charge be not increased—exactly another £2,000,000 sterling." Now, Sir, I ask if this is quite the way to look at this Reserve? It is true that it has cost us, and does cost us—I take it on Mr. Reddie's authority—£200,000 a-year, but the Commission proposed that seamen should only receive £5 a-year, and we give them £6, and that makes a great difference. We have paid in the retainers to seamen in the last year £80,470, and the gunnery expenses which the Commission estimated at £35,000, amount to £120,000. If there is a mistake any way, it is not that you give the seamen too much, but it is in the Department which formed the estimates, leading the Commissioners to give a wrong opinion. At page 19 (296) of

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Mr. Reddie's paper, he says, "The cost of the Naval Reserve is annually more than "the pay of all the officers, seamen, and boys of the Coast Guard afloat, or of those "ashore; the estimate for 1865-66 being only £129,941 for persons afloat, and "£179,690 for persons on shore. Once more; the wages of 8,000 marines actually "serving afloat last year amounted to less than the cost of this Reserve! It actually "costs us about half as much per annum as the whole wages of 16,000 Royal "Marines." I ask, is this a candid way of putting the statement? What is the use of making such comparisons? Compare retainers with wages, and establishment with establishment, and you have something trustworthy to handle; but how can you put the whole expense of £200,000 as against the expense of any service! It shows nothing. It shows that one amount is above the other, but it is no comparison at all as to the services rendered or to the material employed. And again, we must bear in mind, of the £200,000 for the Reserve, a very great part consists of wages and salaries of Royal Naval men and Officers, and that therefore the expense of the Navy is reduced and the Reserve increased. And again, we pay £1,500,000 to the militia and volunteers on shore. Why grudge £200,000, if it costs £200,000 for a reserve like our volunteers afloat? I maintain that the expense is not exorbitant. The next thing is, that the Reserve is wrong in its constitution. The principal objection Mr. Reddie has taken to the present Reserve would appear from his paper to be, that they are subsidised at all. At page 20 (297), he says, "And the "Naval Reserve men, instead of being subsidised, as now, during peace, might be only "paid while under drill, and have this prospect of high wages in the Navy held out "to them during war, and when actually serving." He also says, "We might "limit the number of the paid men in the Reserve to, say 5,000 or 10,000 (letting "the present number gradually drop to that limit), and in future enter another "10,000 or 5,000 only as probationary reserve men, without paying them any 're-"'tainers,' except the pay they would receive while under drill and qualifying to "get on the *Paid List*." I should like to know if many seamen in the mercantile marine would enter the Royal Naval Reserve force on those conditions. I entirely agree in every remark Admiral Ryder made, and, as he said so much to the point on that subject, I feel it unnecessary for me to go into that point again. As he has said what I have to say so very much better than I could have said it myself, I will leave what I was going to say, unsaid. Now, it is unreasonable to expect that our skilled seamen should give one-twelfth of their time for nothing, in the hopes of getting, at some time or other, the choice of serving Her Majesty, under her own flag. As regards its inefficiency, this can only be in point of numbers, and not in character, loyalty, ability, or drill. I made a remark the other night, that Mr. Reddie had over-estimated the number of seamen from which we can draw our reserve. I said the number was 85,604, instead of the number 350,000, which Mr. Reddie has got down, and we had a little conversation about that, and the Chairman very properly said, or very properly as he thought, that as there was no difference of opinion, there was no question, only that I had read the returns wrong. Now, Sir, under correction from you, I wish to say that I have not read the returns wrong. The total number of men serving in ships registered in the United Kingdom of Great Britain and Ireland, Jersey, Guernsey, Alderney, and Sark, and the Isle of Man, is 197,643, and no more, every soul on board. It is idle to take 350,000 as the body from which you can draw your reserves. A large proportion of these 350,000 men never come to these shores at all. There are British registered vessels carrying the British flag that have never been near a British port of register, that are manned entirely by Lascars or other foreigners, and never come near the country at all. How then, I ask you, can you include them in the number from which we are to draw our reserves? As an illustration of how you may be misled by misquoting these returns: In this very number of ships 21,626, and the number of seamen, 197,643, serving in ships registered in the United Kingdom, I may state that there are a certain number of them that never come near this country at all; and how is it? Why, during the American civil war, in order to get away from the "Alabama" and the "Florida," the merchants of New York registered numbers of their ships under the British flag. Those ships are registered as British ships, carrying a British flag, commanded by Americans, manned by foreigners, and they appear in

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this total of 197,643. I then ask you again, how can you take that number as the number from which we are to draw our reserves? But the number from which we really can draw our reserves is only 72,800 able seamen, and 13,456 petty officers. We want to admit those ordinary seamen of whom we have, in ships registered in the United Kingdom, 19,221; we do not want to do away with the Naval Reserve; we do not want to break faith with the men we have enrolled in it; we merely want to alter the regulations, and institute a second class of men. Enter your ordinary seamen who man our coasters—the men whom you can depend upon—the men who man your smacks, and go out to your wrecks—enter these men, who are as hardy and plucky as the British sailor ought to be; make a regulation whereby you can enroll them in your Reserves, and you will do good. Now Mr. Reddie proposes that the Reserve should be abolished; and this is really a proposition so monstrous, so terrible in its effects, that if any person in this room were to tell me that Mr. Reddie was authorised by the authorities to come down here and read this paper, I would say that that statement alone convinces me that he is not. The Admiralty have taken years to knock down the barrier between the British seamen and the seamen of the Royal Navy. They have done at last a good thing. They have got men to serve in the Royal Navy, who never did serve in it before. They are linking the two services together. These men are bound under a contract, and the contract is—"We do a certain thing on our part, you do a certain thing "on yours." Would any one believe that the Admiralty would seek to break the conditions they have entered into with 18,000 of Her Majesty's subjects? I believe the very fact of Mr. Reddie making the proposition will do more to decrease the number of enrolled men in the Reserve than anything that has ever happened before. With regard to Mr. Reddie's plan of a Naval Reserve, I leave that to Officers like Admiral Ryder, who have given their attention to the subject. But it appears to me that if it is worked out, it must take away at least 6,000 of our trained merchant seamen per annum for a period of five years. I ask, is this a statesmanlike proceeding? Is it right that the giant industry of our country should be crippled by having 5,000 a-year of its ablest sons taken away from it for no earthly purpose whatever, when you can do it so much better by having a Reserve as you have at present, and letting our civil population follow their own proper avocations. In making these remarks, I do wish to say, that because I do not propose to have every man in the Navy, therefore those who are in the Navy should rush away from it; I say let your men be all continuous service men. Keep them to the Navy as much as you can, but I do say, maintain the Reserve as well; the one you should have done, and not have left the other undone. Then as to that remark of Mr. Reddie's—and I blush to allude to it—where he suggests to the Reserve men that they may be backward in coming forward, I really feel, Sir, as a Volunteer myself, that he is doing me, and he is doing every other Volunteer, a serious and a grievous injustice, and, I believe, that he is doing himself a greater injustice still. I believe that he is a man of sense, of calm and deliberate judgment, and I am astonished, I must say—I can make use of no other word—I am astonished that Mr. Reddie should, in his study, have put those words on paper. I ask him, are the men who man our lifeboats backward in coming forward? I ask him, are the men who use the rocket apparatus backward in coming forward? I ask him, were the men who went out to meet the Armada backward in coming forward? I ask him, were the men who went and fought at Agincourt backward in coming forward? I ask him, were our Naval Reserve men, who rushed forward to be enrolled in the Reserve at the time of the "Trent" difficulty, and who petitioned the Board of Trade and the Admiralty, that despite other engagements they might be permitted to serve; were they backward in coming forward? No, they were not. I will be bound, if Mr. Reddie will only leave them alone, they will be ready to go to the fight as of old, with the cry of "Heaven for Reddie, England, and St. George." To sum up my remarks, I say, shortly:—First, of all, that according to Mr. Reddie's own paper, the Naval Reserve does not "rig the market" against the Royal Navy. I say that the cost is not altogether out of proportion and beyond the value of the force. I say that the Royal Naval Reserve is not insufficient, and I say it is not wrong in its constitution. I say it should not be abolished in favour of Mr. Reddie's scheme, great as it is, or

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any other scheme. And I do say I hope Mr. Reddie will, in this room, withdraw anything that may be an imputation on the Reserve forces of this country, in suggesting that it may be backward in coming forward. I thank you for the patience with which you have listened to my remarks, and for the sympathy with which you have received them.

[Mr. W. STIRLING LACON here proposed to read a memorial from 170 seamen of the North-eastern ports of the kingdom, but it was not read, as not bearing directly on the question before the meeting.]

Mr. JAMES JACKSON: Sir, I am a member of the Royal Naval Reserve Club, and have taken considerable interest in this question from the commencement, and with your permission—as Mr. Reddie's paper has created some excitement in the country, the Royal Naval Reserve feel that an insult has been cast upon them—I will take the liberty of reading letters from men representing the largest out-ports in the kingdom, touching upon this question, and not upon any particular question of grievance.

The CHAIRMAN: I do not think that this bears upon the subject, because you see you are begging the whole question. It is not that Mr. Reddie said so, but merely that Mr. Reddie's language has been perhaps somewhat loose, and an interpretation has been given to it which he did not mean it to have. The question is as to the Reserve, and not as to Mr. Reddie's language.

Mr. REDDIE: If I might be allowed to express any opinion, I should rather hear Mr. Jackson read what has been stated.

Mr. JACKSON: I can only say that the Officers and men connected with the Royal Naval Reserve feel that they have been unfairly treated in Mr. Reddie's paper, and, speaking as a landsman, and connected with the commerce of England, I think that if a Volunteer service on shore is valuable, a Royal Naval Reserve must be still more valuable. What ought to be the duty of the Government of this country but to protect its shores? Let an enemy once land; let them sack one large town, and you would have paid for the Royal Naval Reserve for ever if you could have prevented it. Now when the question of a Reserve was first discussed, I know that seamen had a great reluctance to enter the Royal Naval Reserve. It was felt that they were to be kidnapped into the Royal Navy.

The CHAIRMAN: Really that is going away from the subject altogether.

Mr. JACKSON: Then I will confine my remarks to this paper, and I have no hesitation in saying that the general feeling throughout the kingdom is one of confidence in the Royal Naval Reserve, and that the men who have entered that service have entered it with a full desire and determination, if war should arise, to the best of their ability to defend the honour of this country. I think that the Officers, too, connected with the Royal Naval Reserve prove that they have the desire to enter the service, if necessary, and to fight for their country. Their first offer of service to the Crown was made when there was a probability of a war with America, and at two great meetings that were held at that time. Lord Clarence Paget and others were particularly anxious, and evinced a great desire to increase the Royal Naval Reserve force, and such a paper as has been read by Mr. Reddie, is calculated to lessen the Force, to disgust the Officers, and to drive them, not only from enrolling, but to drive a large number of them from the Service. We saw a slight notice of the paper in the *Shipping Gazette*, and I happened at the time to meet several distinguished Officers connected with the merchant service, who said "I shall throw "up my commission. When I tendered the offer of my services to the Crown, I "did it as a man of honour and a gentleman, with a full determination if this "country should ever require my services, to fight for it to the best of my ability." And with regard to the value of the Officers of the merchant service, I know it has been stated they are not very good seamen, but they just know the propulsion of vessels by steam.

The CHAIRMAN: That is not in the paper at all. It is a pity to be going away from the question. If mere hearsay and gossip outside is to be produced, there will be no end to the discussion.

Mr. JACKSON: I will just beg to make this one observation: that from such remarks as these made by Officers connected with the Royal Naval Reserve, it

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shows that an impression had gone abroad, and I think we are very much indebted to Admiral Ryder for bringing out so clearly before us in the first instance, that Mr. Reddie's opinions are not endorsed by the Admiralty. I will not take up your time any longer. I should like to have been allowed to read three or four letters, because they materially bear upon the subject. On behalf of the Service, and on behalf of the men, I may say, there was a general feeling of security when it was known we should enrol a large number of men in the Royal Naval Reserve, and that that Reserve would be officered by distinguished men in the merchant service, and I think, as a nation, we ought to be grateful to them, and that nothing should be said that in the slightest degree could hurt their feelings or question their loyalty. ("Read, read.") The first letter is from one of the largest shipowners in the north of England, the ex-Mayor of Sunderland. He says, "Dear "Sir,—Knowing the interest which you take in all mercantile marine matters, I can- "not refrain from calling your attention to the statements in reference to the Naval "Reserve force in our country propounded by Mr. Reddie, of the Admiralty, before "the members of the Royal United Service Institution. This gentleman has had the "boldness to assert that the Naval Reserve force is an inefficient one, and one tending "to keep men out of the Royal Navy. Now, Sir, from my knowledge of the Reserve "forces in this neighbourhood, I can contradict positively Mr. Reddie's statement. "We have here and in the neighbouring ports about 3,000 of the best of British sea- "men—I say the best, because the north country seamen are engaged in healthier "and hardier trades than those who trade to our Southern climes. Well, Sir, remove "the force; let the 3,000 men of the Reserve be disbanded, how many would you "find entering the Naval service? I should say scarcely 5 per cent. of the whole. "They dislike the service. Why? Because in one service they have smaller pay, "and are deprived of the freedom which they possess in the merchant service. But, "Sir, like the Volunteer forces of the land service, the men of the Naval Reserve have "joined these ranks purely from patriotic motives, and with a view to serve in the "defence of their country in the case of need, at a yearly cost scarcely equal to that "which the Admiralty spend in altering any single man-of-war; but the existence of "that force as now constituted, places at the disposal of the country a powerful naval "force for any sudden emergency. Take the advice of Mr. Reddie, and disband this "force; how would you man the Navy? Not by volunteer seamen. They would not "leave the merchant service for the naval, so long as they find profitable employ- "ment in the former. Therefore the shipowners of this country would be indirectly "sufferers in the case of war."

Captain HEATH, R.N., C.B.: The Chairman rightly said that the question before us is, first, whether the Naval Reserve as it now stands should be abolished; and secondly, whether the one proposed to be substituted for it is a good one. The gentleman who spoke last has given two good reasons for retaining the present Reserve, and I will give you one which strikes me as strongly against the adoption of the source proposed, that is, that it will never yield the numbers you hope to get. Mr. Reddie's first source from which he would draw his supply of the continuous service men having served their ten years.

The CHAIRMAN: It does not limit them to ten years.

Captain HEATH: Supposing our whole fleet were continuous service men; supposing the whole 20,000 to be continuous service men, that would give you every year 2,000 men leaving that service. Would those 2,000 men join the Reserve? Would any large number of them join your Reserve? Would any more join than join at this present moment? I do not know what that number may be, but, I take it, it is 100 or 200. Admiral Ryder can tell us.

Admiral RYDER: There are not ten per cent. of the present Naval Reserve who have been in the Navy.

Captain HEATH: Then 100 or 200 men would be the total number you would get from that source. Mr. Reddie would then turn to the merchant men who had joined the Navy for a minimum period of one commission, about three or four years, who might perhaps remain a second commission; that is to say, men who being merchant-seamen originally, joined our service for a few years for the sake of getting enrolled. Captain Selwyn, on a former occasion, propounded a somewhat similar

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proposition. I think that both those propositions are founded on an entire mistake of the nature of the seamen. The genus seaman, species man-of-war's man is entirely distinct from the species merchant sailor. The one is generally brought up from a boy in habits of order, cleanliness, tidyness, with good food and good treatment, or, at all events, regular treatment, and against that, he has his long journeys, and three or four years' absence from England, but that is his life; he has accepted it, and he likes it. The merchant sailor is far from young; he trusts to chance, whether his captain is humane, for good treatment; whether his owners are liberal men, for good food and various things of that sort. He is allowed to dress as he likes, to shave and wash when he pleases. He lives sometimes in very uncomfortable berths, but he has his quick returns to England. He returns to his wife and family very often, at intervals of months, never at longer periods than one year. Now these two classes of men will never, at your beck and call, either serve in one shape or the other. There is one point in which the condition of the seamen of the Royal Navy might be improved, and Mr. Reddie might himself improve it, and that is, in their money affairs. They are now managed at Somerset House. A man comes home from abroad, having served on a foreign station. He is invalided. He comes to England. His pay tickets go to the Admiralty, but the paymaster is not allowed the credit of having calculated it properly, and they must be audited at Somerset House. He is kept on board the flag-ship sometimes as much as ten days, waiting for those papers, not allowed to go home. He goes on shore, borrows money, and pays an exorbitant interest for it. He spends it, and goes home with nothing. That is one small grievance, which I hope Mr. Reddie will take notice of.

Vice-Admiral J. H. CODRINGTON, C.B.: I am not going at this late hour of the night through all these tables; they would require much more consideration than I could give it in the short time I have at my disposal. I think, with respect to them, that we must give our thanks both to Mr. Reddie and to the gentlemen who have addressed this meeting on both sides of the question, for the pains and labour they have taken about it, and the way in which they have opened it up. I now want to draw your attention to another matter. There is a paper which has been put up on the wall, containing certain resolutions, and worded "We resolve" so and so, "We are of opinion" so and so. Now if that is put forward as that this meeting is to give its opinion in one way or the other on this question, we are certainly stepping out of our province. If I apprehend rightly as a Member of this Institution, we meet here in the evening with the other Members of the Institution, and the friends whom we may invite, to hear and discuss such papers and such illustrations as any gentleman may be good enough to take the trouble to come and read and show to us here. Whether he be right or wrong, the agitation of the subject gives us a great deal of information. It may possibly improve him, for aught we know, but it certainly improves us. We also gain much from the criticisms, as we see below there. But, Sir, I would not as a member here give my vote for this proposition or for that. It would be out of my province entirely. We should not pledge the meeting. We are here as individuals, members or friends; private persons almost, but we should be *quasi* pledging this Institution to certain resolutions on the one side or the other. We have no authority to do that in any way whatsoever. I think we meet here to listen to information, but not to pledge this Institution to any course. I may almost say more. I am rather sorry to hear the name either of the Admiralty or of any other Public Department brought forward in this theatre. I can recognize only the members in this Institution and such gentlemen as are good enough to come here and speak their opinions as individuals. I know nothing of the Admiralty here. The Admiralty or the Horse Guards are all the same to me; we are here as individuals. Whoever stands up to give us information, stands up as an individual, without pledging his Department, and I do not think he should say anything to commit any one Department. We are much more independent and in a higher position as members of the Royal United Service Institution than we could possibly be as partizans of one Department or the other. If any resolution were to be proposed here, I, as a member of this Institution, should walk out, for I would not be a party to it.

Commander W. DAWSON, R.N.: I have already spoken, but I spoke under pro-

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test; as not having the paper in my hand I could not enter into the details more particularly. It appears to me that there are several other gentlemen present who would wish to join in the discussion. There are several Officers of the Royal Naval Reserve here, and a number of other gentlemen who would like to speak also, and the remarks I was going to make could not possibly be compressed into five minutes. I rise therefore for the purpose of proposing the adjournment of the discussion to another night.

Mr. REDDIE: I trust, before you come to a decision upon that proposition of Captain Dawson's, that you will allow me this evening to say a few words to remove some of those misapprehensions, and get rid of some of those issues which have been—unfortunately, I think—imported into this discussion, and in a very unusual manner. I would not have come to this Institution to have read a paper if I had thought I would be subjected to a personal attack, or told that I was coming here as the mouth-piece of the Board of Admiralty. I have denied that already, and will not condescend further to allude to it. With reference to my own paper, and the propositions I have made (or rather the suggestions I have thrown out, and the arguments I have used), I have by no means proposed the abolition of the Royal Naval Reserve, and the substitution of any other force. My paper will speak for itself. I have brought out certain issues as regards the present Reserve; I have brought forward certain views which, instead of being the views of the Admiralty, have been shown to be contrary to the views of the Admiralty; because in my paper, if you draw any deduction at all from it of a very positive kind, you will see that I argue we have now a sufficient number of boys to keep up our standing force. Admiral Ryder has asked me about the number of boys to be voted this year, and I find there are actually 400 more boys. I did not speak with reference to the Naval Estimates, but as an independent man, forming my own judgment upon certain statistics which I have laid before you. But those views which I have advocated as regards the Royal Naval Reserve (which I think might be made a much better Reserve if it were composed of seamen who had had four or five years' service in the Navy, similar to the *Inscription Maritime* of France, which is a reserve formed of men so trained), you will find are the very same views, as regards the character of the Reserve, put forward in a very able book, which, I believe it is no secret now, was written by Admiral Denman—not a layman, not a landsman, but a man just as worthy of respect as any Naval Officer who has spoken on this subject on any occasion; and he tells you that the 28 days' drill will not make much of a trained man for you, unless he happen to go on board ship immediately afterwards. You will find at page 102, of "Admiralty Administration," this opinion:—"Looking "to the amount of skill in gunnery now required to make an efficient man-of-war's "man, it is evident that 28 days' drill in the year will place them not materially in "advance of untrained men, unless they happen to be called on for service just after "the expiration of the 28 days' training." Now if I happen to hold the same opinion, what about it? I am rather surprised to hear Naval Officers think a man-of-war's man is not better than a merchant seaman, trained for a few days in the year.

Admiral RYDER: Who said so?

Mr. REDDIE: It is implied; you seem to think that they will be a perfect Reserve. Well, here is a difference of opinion. I have merely put forward my views. I think they are worthy of consideration; and they are now in print, and it is really of very little consequence whether certain Naval Officers have formed a high or a low opinion of the Naval Reserve. A great part of Admiral Ryder's remarks consisted of "we believe!" His posting up these mere opinions of his own, and with meagre extracts from my paper reminded me something of Mr. Bright posting extracts from Mr. Lowe's reform speech in the workmen's shops, intending to throw a kind of odium upon him! And all because I used an expression about the Reserve men, which certainly did not apply to the officers, as Mr. Jackson seemed to think, for I have never mentioned the Royal Naval Reserve officers in my paper once; and we know perfectly well there are none of them paid, and so it could not apply to them. Now, I merely pointed out that the men, according to the present rule, unless you pay them the retainers during war, would be actually receiving less pay when they

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are fighting for you, than they are now getting in time of peace; and I said that *if* you found men under those circumstances backward in coming forward—and recollect they have to consider their families—it was not to be wondered at. Moreover, consider that ten years hence you will not be dealing with the men you have got now. I hope when papers are read here, or in any other Institution in this country, people will speak out; and I beg to say that there are an immense number of opinions that I do not entertain myself that have been attributed to me, but are not to be found in my paper. But, even, if the discussion is to be deferred, it will be out of the question to go into these figures of Admiral Ryder's. But there is one remark that is pertinent to the subject—and I think this is really the only remark I care to reply to—and that was brought forward by Captain Heath. He tells you if you have a Reserve of the kind I propose, you could not get the men. Now I point you to this table (Table II, Appendix A), and it will show you where you are to get the men. In the five years from 1861-62 to 1865-66, 29,182 seamen of all sorts were discharged from the Royal Navy, and of these, 19,000 were pure blue jackets.

Captain HEATH: They did not go and live in those forecastles, and eat the food that we hear of in the merchant service. They went somewhere else.

Mr. REDDIE: There were 19,000 pure blue jackets who went out of the service in those years; and my proposition is, that just as you might at the close of the Russian war, have paid some of those 13,000 who then left you in two years, a certain sum of money, when you could not employ them in your ships, and enrolled them (and they would have considered it a compliment to enrol themselves) as a Reserve force while they went to take a turn in the merchant service; I say so, you might have enrolled great numbers of these also. No one of the gentlemen who have spoken has paid any attention to the modifications which were plainly enough stated in my paper, as to those inducements I hold out, both for the merchant seamen to go into the men-of-war, and for the men-of-war's men to go into the Reserve; but as they are all recorded they will speak for themselves. I really do not care much to go into mere matters of opinion, when what is already stated is printed, and will stand side by side with what others have alleged.

I come now to Mr. Gray's correction of the numbers of merchant seamen. Well, granting that out of 350,000 men, who are given in Mr. Gray's own returns as the crews of merchant vessels—granting that you must eliminate a very great number of them—certainly a very great many according to Mr. Gray, because you must not only take off about 94,000 that belong to the British possessions abroad, but he says you must reduce the 255,000 that still remain, to 72,000. Well, Sir, I will accept that—that you have only 72,000 able seamen in the mercantile marine—but is that the slightest argument against a system which will increase those numbers? What I have argued is, that if you will turn our men into the merchant service, and take men from it less qualified, we will qualify them for you and send them back to you after we have trained them. Well, then, what answer is it to tell me you have badly qualified men in the mercantile marine? I claim that as my argument, because I will give you more qualified men; and you will find in this same book, "Admiralty Administration—its Faults and Defaults;" and I suppose people will not say it was written in the interest of the Admiralty—this opinion expressed:—"Instead of our men being forced to engage for so long a period as ten "years, or to lose nearly five pounds a-year by taking a non-continuous rate of pay, "they might be entered for five or even three years, by which means twice or three "times as many men might be trained in the Navy, as under the ten years' entry, "which necessarily reduces the number of trained men in existence to a minimum, "and practically bars any interchange between the two services"—the thing which Mr. Gray seems to rejoice in; for he says—"Let the Navy sailors stick to the Navy, and let the Naval Reserve stick to the mercantile marine—"

Mr. GRAY: I beg pardon; I never said anything of the kind.

The CHAIRMAN: No, but it comes to that.

Mr. REDDIE: I think that is a much fairer interpretation of what he said, than what he gave as an interpretation of what I said. The book goes on—"practically "bars any interchange between the two services, so essential to efficient reserves;

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" for no man can be thoroughly trained except by actual service on board a man-of-
" war, and it would be most desirable to include as large a number as possible of
" men thus effectively trained in a first line of Reserve, if Reserve it may be called,
" one which ought to be in fact an advanced guard (p. 117)." I think the merits of the question are pretty well met in what has been advanced already; but I must make one remark with reference to what Admiral Ryder began by saying about the propositions that he made to the Admiralty,—and recollect he ought to have stated, it was not merely to the present Board of Admiralty, but to the last Board of Admiralty. Now I do not know whether the two Boards were actually of the same opinion upon this subject—it will be perhaps very remarkable if they were—or whether I equally represent them both, if they both differ in opinion! But there is one thing that Admiral Ryder omitted to tell you. He told you he had recommended an enormous increase of boys; and he knows what answer he got, not from civilians at Somerset House, but from Naval Lords and Admirals at Whitehall, upon that subject. I did not want to go into these matters, but they have been brought forward in such a prominent way that I feel a great temptation to read from this paper, written by one of those Admirals, but I refrain. There was one thing, however, the gallant Admiral forgot to tell you. Mr. Gray has charged me with a certain statement. You will find it put, if I did say it, very mildly in my paper, and certainly as if I had drawn it from some other source. The Admiral has sat and heard me accused of saying that the Reserve has stopped the entry of seamen into the Navy. Now I should like to know how that idea got into my head. I was surprised that Admiral Ryder did not stand up and say that it was he who has alleged that—has alleged it over and over again. He has put it in print, although he has not sent me a copy of the memorandum which he wrote and printed, on the subject, and although he promised to do so. If he had sent it I should have read it to you. You will observe, however, that what he states, as to the want of the proper number of boys, relates to the year 1865, and consequently that did not relate anyhow to the present Board of Admiralty. He has given you an almost frightful account of the way in which the boys vanish from the service. Well, while he was going through those statistics, with which I am pretty well acquainted, I added up the numbers of boys in a return that I have given to him,—for there is nothing which I have not placed at Admiral Ryder's disposal throughout, although he has not returned me the compliment,—I have added up the numbers of boys borne in Her Majesty's ships from 1858-59 down to 1865-66, and they amount to 63,096. Now if you divide those numbers borne—this is a very simple way, a much easier way than in that interesting diagram with lines running about in a way that I profess I do not understand—you get here a total of 63,096 boys borne in that time. If you divide that by four it will give 15,750. Well, you actually get more than one-fourth of your boys borne, rated into men and stopping with you—not dying and invaliding, for I do not understand the process by which either dying or invaliding is to be accomplished which the Admiral put forward—you have actually got in that same period, out of these numbers borne, 16,985 boys rated as men: so that if you simply take the numbers of boys borne in the table that I have laid before you, you may calculate that at the end of a given period,—(not in the three years of the Admiral's experience at the Admiralty—while we were reducing the forces, when you will find in the Navy Estimates smaller numbers voted, and hence this drain that he speaks about)—you will find, if you divide that number of boys by four, you will get nearly the numbers of men rated. That very simple calculation will put all these statistics on one side, though I understand from the Admiral that he is going to print them with his speech. I am very glad that he is, because I put that very plain statement as against them, and you will see which will last the longest; for these figures are actual facts.

Admiral RYDER: Mine came from Somerset House.

Mr. REDDIE: Not the manipulation of them.

Admiral RYDER: I beg your pardon. All checked in their present state, and said to be absolutely true. I can show it you in writing.

Mr. REDDIE: We have never differed about some of the numbers, because we have given you them. It is only a question of how you use them. There is one

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point I must notice with reference to this proposal of training many boys in training ships. The Admiral said the waste there was 14 per cent., and only 7 per cent. in sea-going ships—that alone must be a consideration. Of course I have not put any proposition forward of a definite kind. I have put forward things which I regard as of grave import for consideration, and I am sure they will be considered. The Navy Estimates amount to a very large sum of money, and we should remember what the waste of boys will be, if you train to the large extent of 20,000, as some have advocated. We know what the author of that pamphlet *on Naval Expenditure* has said, and I have got it already in my own paper, therefore I shall say no more about it. I am sorry such an issue as that, for instance, has not been discussed at all to-night. We have gone into what relates simply to the administration and the management of the Navy at the Admiralty, and not even that, in a profitable way; for this is what relates to 1865, and really I do not think you want to know to-night whether the Lords of the Admiralty of that period did their duty or not. Should the discussion be adjourned, I am prepared to stand by my paper. I withdraw nothing.

The CHAIRMAN: The question has been proposed that there should be an adjournment. One of the reasons assigned is, that some of the Officers of the Reserve may wish to speak; but really I do not see why they should be called upon to speak to this question. The question raised by Mr. Reddie is not one for them at all. We have had all manner of suggestions, which do not seem at all to the point—that letter of the Mayor of Sunderland, for instance.

Mr. JACKSON: That is a matter of opinion.

Rear-Admiral Sir FREDERICK NICOLSON, Bart., C.B.: I beg leave to say that as the Officers of the Royal Naval Reserve are entitled to be members of this Institution if they are inclined so to do, should there be any present, and they would devote a few minutes to this question, I am quite sure that the Chairman and all the members here would be only too happy to hear what they have to say; but as it is nearly eleven o'clock, I am afraid we have but very little time this evening to finish this discussion, though for my part I should be sorry to see it adjourned, for these continued adjournments prolong the subject much, and it is almost impossible to carry in one's head, all the previous arguments adduced. I think it would be a great pity, if there are any gentlemen present who would wish to occupy a few minutes, that they should go away with the slightest impression that any member of this Institution is not most anxious to hear them.

Captain HUNTER: There is one portion of Mr. Reddie's paper that I should like to make a remark upon. I think he said there was a smaller number of men in the merchant service available for the Reserve, and that all the ablest men were in the Navy. I think that was his statement.

The CHAIRMAN: It was not Mr. Reddie's statement. It was I who compared the numbers.

Captain HUNTER: He gave that as a reason why we should do without the Naval Reserve.

The CHAIRMAN: I said it was suggested.

Captain HUNTER: Well, now I should like to ask how the Navy was manned at the time of the Russian war? how the Baltic fleet was manned? Is it not notorious that men were picked up in the streets of London and other large towns? Is it not certain that those men were sea-sick, and not able to sweep the decks for the first week? And would not it be a great advantage if you had 8,000 or 10,000 Naval Reserve men, with 28 days' training, ready to be put on board ship at any time? Is it quite certain that if the Russian fleet had come out from its harbours, our fleet would have been found quite so formidable as people thought?

The CHAIRMAN: Quite!

Captain HUNTER: I think it is doubtful.

The CHAIRMAN: Not the least doubtful!

Captain HUNTER: I think, instead of doing away with the Naval Reserve, that if you would relax your rules and extend its limits a little, and take in fishermen and the men along the coast, it would be better. If all these men were enrolled in your Naval Reserve, it would become a very formidable force, and we should be very

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much better prepared for fighting. I say, you cannot do without the Naval Reserve.

The CHAIRMAN: At this late hour I ought not to occupy your time. It is very true Mr. Gray reduced the numbers very much, but you will observe whatever reduction was made of the numbers from the 350,000, the same must run through the whole; and therefore if you say that in 1813 we had 147,000 men in the Navy, and 165,000 in the mercantile marine, you must reduce them down in the same way, and you only get 72,000 available.

Mr. GRAY: I never said anything of the kind. Your statement was that as we could do without a Naval Reserve in 1814, we could do without one now.

The CHAIRMAN: Certainly, it was suggested by the totals.

Mr. GRAY: My point was this: Mr. Reddie said there were 300,000 men, and we only get 16,000 in the Naval Reserve. My point was to show that there were not 300,000, but 72,800 able seamen and 13,456 petty officers, and out of these we got the 16,000.

Mr. REDDIE: It is no part of my argument. I did not put the argument at all in the way you put it. I never made any such remark in my paper, nor in what I said to-night. That is one of the things you put upon me.

Mr. GRAY: I tried to condense it for you.

The CHAIRMAN: I think it is a great misfortune that the question has really not been discussed. We have gone off the issues, and have scarcely said anything about the Reserve at all, therefore it is impossible to give any opinion about it. That question has not been discussed; but I do say that there is a point arising out of it that is deserving of inquiry, and that is this. The Reserve have had a distinct assurance that they will not be called out except in the case of a great war. Now if a great war does not occur for twenty years, and if the waste takes place as is represented by those figures—21,000 men enrolled, and 5,000 wasted in the short period during which they have been enrolled—I want to know where will be these 16,000 men, with that continuous waste going on, in ten years, much less in twenty? You will have paid a number of men, and this number of men will have wasted; they will have died off, have been invalided, and not have come forward. So that literally you will have paid them money for nothing at all, and there is great want of economy.

A VISITOR: If there is no war you will have got your men cheap.

The CHAIRMAN: For what? Paying them for doing nothing?

A VISITOR: By their being always ready.

The CHAIRMAN: I say no, because what you really want them for, is a contingent force. It is just the very difficulty; there is no provision made for that which is the most important of all, and that is a warlike demonstration. Actually, the very thing which keeps off war, you have not the means of doing. You dare not call them out. You want to make a warlike demonstration; and we know very well that if a warlike demonstration had been made at the commencement of the Russian war, you would have had no war at all. It was because the Russians did not believe that you would go to war, that they went to war. Now I say one of the greatest defects is just this, that there is not a contingent force that you can call out. No doubt you have the marines. Mr. Gray said he did not see that there should be any comparison between the marines and these men. Now I say there is, very distinctly. If you can put 8,000 marines on board, and can get landsmen to fill up, and they are useful, more particularly now, as you have better means of training them than you had during the war; by the arrangements of your gun numbers and auxiliaries, you have means of using landsmen to a greater extent than formerly. Therefore I say it is a very great defect in the existing system. And it ought not to be judged from any personal feeling, for if men are really patriotic, they will look at it in a patriotic point of view, and not from a personal point of view. I have no hesitation in saying this has been no personal question, and it is quite out of place to take expressions of that sort and twist them into personal questions. It is a great defect, that what you really want the men most for, is for this contingent supply which actually prevents war; you are not allowed to do that, and you are indefinitely paying men really for nothing.

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A VISITOR: But if the recommendation of the Commission had been carried out, you would have been able to make your great demonstration without having to call out your reserve at all.

The CHAIRMAN: That is a defect existing now. I am dealing with what is, not with what might have been.

A VISITOR: They ought not to be disturbed, your second reserve; you are disturbing your second reserve. Keep those men for your second reserve.

The CHAIRMAN: I am not dealing with anything that does not exist. If there is an alteration, then that is an admission of the defectiveness of the present system. I say this discussion has gone off upon irrelevant issues, and that we really have not got the main question discussed at all.

Commander DAWSON: We should like to hear Mr. Reddie's side argued, and I expected to-night we should have had Admiral Erskine present and others. I wish to hear their side of the case.

The motion for the adjournment having been seconded, the meeting was adjourned to Tuesday, March 5th, at half-past eight.

ADJOURNED DISCUSSION.

Tuesday Evening, March 5th, 1867.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

The CHAIRMAN: We will resume the discussion on Mr. Reddie's paper. We all recollect, I dare say, that the first Emperor of the French said, that the position and influence of a nation depended upon the number of men it could immediately bring into the field. I think we shall all be inclined to endorse that opinion. And the real object of this paper is to make provision whereby a large number of men can be called upon and made available in a short time. That, the real, the proper point of the paper, having been left untouched in the discussion, I think the meeting will agree with me, that if any gentleman has any objection to that point,—I mean, if he thinks the plan proposed by Mr. Reddie is not practicable, or if he can suggest a better plan for the purpose, we shall be glad to hear him. I repeat that that is really the main object of the paper; and I must say that I think that any gentleman who takes the same view of the matter will be the best person, first to address the meeting.

Mr. FREDERICK WOOD, of the Mercantile Marine Office: I am fully aware that it may appear very presumptuous in me to rise first to address this distinguished assembly. However, good Generals put their worst troops forward first. As an additional excuse, I may mention that we do not meet here as Officers, nor as officials of high or humble grade, but as Englishmen equally interested in the welfare of their country, and the maintenance of the maritime supremacy of Great Britain. I feel painfully impressed with the difficulty of the task of saying anything that shall be interesting to this meeting, after the very lengthy and able—I beg your pardon, I should reverse the order—after the very able and lengthy speeches that we have had the pleasure of hearing on the two previous occasions. I shall confine my remarks entirely to that portion of the paper that treats of the Royal Naval Reserve; and I hope that the truth will be elicited at this meeting, whether it is, what its name imports it to be, or whether it is an expensive and useless sham, not only without any practical utility, but actually detrimental to the service it was called into existence to supplement. It is not my intention to speak of the Officers of the Naval Reserve; merely of the seamen. I see no mention of the Officers of the

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Naval Reserve in the paper, and I suppose they have been omitted for some very good reasons. There are very good reasons certainly, each one of which is really sufficient; and I have no doubt there are reasons which influenced Mr. Reddie in omitting the mention of the Officers from his paper. In the first place, being gentlemen of honour, it is to be supposed—

The CHAIRMAN: The real point is to discuss the paper. It would be desirable that you should confine your remarks to the paper.

Mr. WOOD: I will endeavour to do so. I am coming to the point whether or not they would have any option.

The CHAIRMAN: You are not discussing Mr. Reddie's paper.

Mr. WOOD: I am saying that it would not matter much to the nation whether they did or did not, because the Navy List has sufficient Officers to command the fleets of the entire globe. That may be the reason why they are passed over, and why the paper refers to the able seamen principally. The Naval Reserve is considered by Mr. Reddie as a very expensive institution. On the contrary, I think it a very economical one. The total expense is stated by him to be £200,000 per annum. No one can be better informed than he, or have better opportunities of getting at the statistics; therefore I must assume that that sum, as stated, is correct. We have 16,500 men in the Reserve. We will say 16,000, because the 500 will allow a margin for losses and deaths not yet reported. Now, 16,000 men at £200,000 will give us £12 10*s*. per man each year.

The CHAIRMAN: I must really call you to order. I think it is unfair, taking each individual separately. The question of expense is comparative.

Mr. GRAY: I think Mr. Wood is in order. We are enabled to judge the cost better in this manner than by dealing with large amounts.

Mr. WOOD: I say that that cannot be regarded as an extravagant sum to pay for 16,000 well-drilled first-class British seamen, always in readiness for the defence of this empire. I am aware it may be objected that these men are not always in readiness, as they are often away on foreign voyages. They may not be always available for the defence of the realm of England; but they are available for the defence of the empire, because they are liable to be called out to serve in any part of the world, wherever they may be, to take their place on board a man-of-war at once. The paper also contains a complaint, that a great many men "slip through our fingers;" that is to say leave the Naval Reserve after one, two, or three years' drill. The money spent upon these men, our author considers entirely thrown away. On the contrary, I think it is well laid out. The force is reduced every year by men leaving it for drunkenness, or misconduct. It enables us to be assured of the steadiness and reliable qualities of the remainder, as none but well-conducted men can possibly remain in the force. In the event of a great war, there is no doubt that all the resources of this country would be severely taxed, and that a bounty would be offered for volunteers. Then, we should find, that we had "thrown our bread upon the waters," and should "find it again after many days" for there would be a great difference between men who have mastered the rudiments of their drill, and possibly be able to take their places at a gun, and men who have had no drill at all; and the men, who would have left the Reserve through irregularity, would be the very men who, in case of war, would come forward and greedily accept the bounty that was offered. I ought to admit that a great number of the men who have left the Reserve, and I am sorry to have to admit it, are very good men, indeed, who have served their five years, and then left the Force. That is a loss very much to be deplored. The reason is that the terms so far from being advantageous, as stated by Mr. Reddie, are not sufficiently advantageous to induce first-class seamen to remain in the Reserve. The £6-retainer should not be augmented; but 21*s*. a-week is by no means a high price for a skilled artizan. Now, if a man is reported by the Commanding Officer of the drill ship to be a well-drilled man, he might receive some little advance in his weekly wage; and a class of petty officers might be called into existence who might receive 30*s*. a-week while on drill. It would be great presumption on my part to make these suggestions; but I happen to know something of both the wishes and the ideas of the men themselves. Not having the presence of their superiors, they are more communicative when I come in

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contact with them. The Naval Reserve as it is at present constituted, has had the advantage of being well considered by a man of very great experience,—the late Captain J. H. Brown, R.N., Registrar-General of Seamen, who was one of the originators of the Reserve. I do not wish to trouble you at any length, but I have a few remarks of his which I should like to read.

The CHAIRMAN: I do not think your proposition to the point, because, after all, the opinion would be that of a man interested in his own child.

Mr. WOOD: I beg your pardon. At the time he penned those remarks he had retired from active service, and had nothing to hope from others. It was very shortly before his death, and some time after his retirement. He said, "However "perfectly a standing peace navy may be regulated, it must be increased and sus- "tained in war from the only available source, the mercantile marine, and as the "men drawn from that source will stand side by side with their brother seamen of "the fleet, and share with them the perils of war, it is most desirable that they "should be competent for that purpose. The recent formation of a Naval Reserve "has relieved the anxiety and apprehension so long experienced as to the means of "promptly manning the fleet, and the best seamen in the nation well-drilled are "now available for increasing the *personnel* of the Navy to a considerable extent. "To foster and encourage it is to consolidate the mariners of the kingdom of every "degree into one fraternity—to establish the means of utilizing our vast resources, "and to demonstrate its overwhelming superiority. This is the best policy for "averting war, or, should such a calamity occur, for ensuring a speedy and suc- "cessful termination. The *personnel* of an extensive Navy is now secured, and "means adopted to improve it without detriment to the usual occupation of sailors, "or the interruption of trade and navigation." Now, that last remark I consider very much to the purpose, as it is above suspicion, dictated by no other motive than the welfare of that country which he had served so long and so faithfully, both on shore and afloat. I shall not go into any details connected with this scheme probably, because I am not competent, as I have been suffering from statistics on the brain since our last meeting. I would entreat gentlemen present, to look upon this question with more statesmanlike, broader, and more comprehensive views. Is it desirable that the Royal Navy should exist as an isolated institution, having its Reserves and its contingents attached to itself, and not resting upon the broad basis of the mercantile marine? This, I say, is a fatal error. All history proves that a State Navy, whether it be Imperial, Royal, or Republican, can only co-exist with, and be dependent upon, a prosperous mercantile marine. We find the Phœnicians and Carthaginians were powerful at sea simply because they were maritime traders. We find Athens boasting of naval victories, because her spirit of mercantile enterprise was equal to our own. To come to the mediæval ages, we find that the Imperial power, and the Ottoman, vast as it was, could not create a fleet simply by Royal authority, to match the navies of the two trading cities of Venice and Genoa. And to come to still more recent times, we find that of our three great rivals for the empire of the sea, Spain, Holland, and France—

The CHAIRMAN: You must be good enough to keep to the point. This is history. This is not in the paper. You really have not been referring to the paper. For instance, with respect to the estimate, it is a comparative estimate, it is not an absolute statement, with respect to cost. You have been arguing as if it was an absolute statement with regard to the cost per day. It is not so. The statement in the paper is a relative statement with respect to the cost of the plan proposed. So that your argument is foreign to the matter altogether.

Mr. GRAY: Under your correction I would beg to remark that Mr. Wood's statement is to show, that a Naval Reserve is not dependent upon the Royal Navy, but is dependent upon the mercantile marine. If Mr. Wood shows that, he strikes at a fundamental part of Mr. Reddie's paper.

The CHAIRMAN: What Mr. Wood has been saying is perfectly foreign to the point—it has no bearing at all upon Mr. Reddie's paper. He has been talking, as I said just now, with respect to the cost "per head." It is not "per head;" it is a comparative statement. Mr. Reddie's plan would provide, not simply a Reserve in time of war, but a Reserve to meet all the exigencies of the State; and he proceeds to show

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that the same sum of money which provides for calling out the present Reserve only in case of war, will provide a Reserve that will be suitable at all times. As you will see, if you will look at those tables, you constantly require, one year with another, 30,000 men, and those men are not available. It has been stated by Admiral Ryder that the effect of the Reserve is to keep men out of the Navy. Look at the Table on the wall (see page 292), you see that in 1861-62, the first entries were 1,414, and in 1862-63 they were 673. That has not been spoken to at all.

Mr. WOOD: I will endeavour to profit by your correction, and speak to the purpose. So far as the Naval Reserve, as proposed by Mr. Reddie, is concerned, it may be very ingenious in its details; but there is this difference. It would be composed of men who have been discharged after ten years' service in the Royal Navy, or continuous service men.

Mr. REDDIE: It is not so in my paper.

Mr. WOOD: I understood you to say it would be composed of men who had served ten years.

Mr. GRAY: I would ask whether Mr. Reddie's paper in substance is not that the men who have served ten years, or continuous service men, shall form the Reserve?

Mr. REDDIE: Not continuous service men—those who have served a commission. A commission is for three or four years. A continuous service man is a ten years' service man.

Mr. WOOD: I admit the correction. But I still contend that under the present system we obtain in the Naval Reserve, as at present constituted, men of far greater intelligence and greater respectability than the men that can possibly be included in the scheme of Mr. Reddie. The best men in the Navy remain in the service, because they obtain promotion as petty officers, and they are infinitely better off than the men in the mercantile marine. I assure you there are 1,200 men in the Naval Reserve who possess certificates as masters and mates in the merchant service. To them it can surely be no gain to belong to the Naval Reserve. We have 2,900 and upwards who have been petty officers in the merchant service. These men belong to the Naval Reserve, not from any profit attaching to it, but simply from patriotic motives. I am afraid I may move the ridicule of people present. I am not wishing to pourtray the British tar as he exists in the nautical drama, and in Dibdin's lyrics; yet let us not go to the other extreme, and deny that he has that patriotism, that love for his country and honour for his flag, which I hope is common to all classes of his countrymen. These men must be far superior in their training, education, and intelligence. Though I do not know that that may be considered actually necessary, still I consider an intelligent body of men will always be more valuable than the men who have not those advantages. The Naval Reserve, as it is at present constituted, has now become a permanent institution. I think it is futile to attempt its overthrow. And even if its abolition could be effected, it should be regarded as a great national calamity, a cause of national regret that the one bond of union between the Royal Navy and the merchant service should be rashly severed. In geometric phrase it is the one point of contact between the two circles; it acts as a connecting link, and has already, during the brief period that it has been in existence, considerably modified, if it has not completely extinguished the old dislike and reciprocated contempt that unhappily existed between those two noble services. They are beginning to learn more of each other, and to know that if the Royal Navy is the more glorious, the merchant service is the more useful, and that they are both equally necessary to the British empire. I thank you for the patience with which you have listened to me.

Commander DAWSON, R.N.: I will speak decidedly to the paper, and nothing else. I begin to compliment Mr. Reddie on having produced a very able paper, one which has excited more attention than any which has been read in this Institution since the hard-contested battle of the guns. This is the third night's discussion, and I think that is a compliment to which Mr. Reddie ought not to be insensible. I say this at first rising, because I think it would be a very great pity that any gentleman who has devoted his talents and time, and has come down here to read a paper in this Institution should go away with the impression, that however we may differ from him in opinion as to different points of that paper, we do not appreciate the trouble he has taken for us. With these preliminary observations I

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will go through some of the arguments of the paper, as briefly as possible. Great exception has been taken to the question of the expense of the Royal Naval Reserve. The objections which have been raised appear to me to be equally applicable to any Reserve whatever, whether it be to Mr. Reddie's proposed Reserve, or to the Reserve that now exists. It appears to me that we cannot have in this country the blessings of free institutions without having some of their pains and penalties, and one of the pains and penalties is, that if we have not despotic authority, whereby to make the public weal compulsory upon the people, we must act by strong inducements. Now one of the strongest inducements is money; therefore we put money forward instead of despotic power. Reference has been made to the Prussian Landwehr. If we could only get Count Bismark to come here and take Lord Derby's place, there is no doubt we could get our reserves much less expensively. Also the *Inscription Maritime* of France; if we could only bring it to England, it would suit all our purposes. But we cannot import their regulations, unless we bring the French Emperor and his system with them. Therefore we must substitute monetary power; and when we compare the expense of the Naval Reserves with the expense of the Military Reserves, I think we shall see that we have not gone to any very great expense on this service. I see the cost of the disembodied militia and yeomanry amounts annually to £1,362,000.

The CHAIRMAN: I would ask you to contrast it with the proposition of Mr. Reddie.

Commander DAWSON: I am going to contrast it: that is, the cost of the whole of the Military Reserve, as contrasted with the Naval Reserve. If we were to carry out the argument that has been used in this discussion, it would appear that if we had ten years of peace we should have expended £13,000,000 on military reserves for nothing. But is that money expended for nothing? My impression is that the Volunteers of this country are doing the country a very great service. They are strengthening the hands of the Foreign Minister in all his dealings with Foreign Powers, and destroying those periodical panics that we had in this country; and so creating a sense of security. It appears to me, that it is very much the same as a life insurance. If a man insures his life, and he should live to 90 years of age, he may deplore that he has spent his money, but he cannot deplore that he has lived 90 years.

The CHAIRMAN: You will observe that that is admitted in the paper.

Commander DAWSON: I see the total cost of the Royal Naval Reserve is, according to the Navy Estimates, £210,111 annually. I find this has been compared by Mr. Reddie with the cost of the Royal Marines. Now let us go into that question clearly. The cost of 16,904 marines is £996,077; that is to say, you will find by a little calculation, that supposing we broke up the 16,000 men of the Royal Naval Reserve, we would get in lieu of it, for the same money, 3,642 Royal Marines.

Mr. REDDIE: Will you allow me to explain to you? I compared the expense of the existing Royal Naval Reserve with the wages of the marines.

Commander DAWSON: You compared two things that are dissimilar. You did not compare the wages of the one with the wages of the other.

Mr. REDDIE: Yes, I did; and if you will allow me, as it will save time, I can show that you are comparing two dissimilar things. You are comparing the wages of the marines, including the expenses of their Officers. Now this Naval Reserve has no Officers who are paid. I therefore compare the wages of the men in the marines who are doing service for you, with those of men who do not serve you, and I say that the cost of the men who do not serve you, is equal to the wages of 8,000 marines who do serve you.

Commander DAWSON: With all submission to Mr. Reddie, I submit that those additional 3,642 Royal Marines who would be kept in barracks, would be a reserve doing no duty for the country, so long as we have the misfortune—if it be a misfortune,—to be at peace, any more than the Royal Naval Reserve are, and that if war broke out, we should have by the present arrangement, instead of those 3,642 marines, 16,000 of the very best seamen in this country—in my opinion, from personal observation—exceedingly well trained. I must depart a little from the paper to notice one point in the discussion that took place. The Chairman has told us, as far as I

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understood his words, that in the last five years there has been a waste of 5,000 men of the Royal Naval Reserve, that we have paid them money, but they have disappeared from the force, and we have therefore so much loss. We can only arrive at a just appreciation of this waste by comparing it with the waste of other services. Now I find in coming to the figures, that this represents a waste of 6¼ per cent. per annum. Mr. Reddie assures us that the waste of the Royal Navy is 10 per cent. Admiral Ryder has told us it is 14 per cent. It may be quite possible that the Chairman was mistaken in the elements of his calculation.

The CHAIRMAN: The Chairman made no calculation at all. The Chairman merely stated a fact.

Commander DAWSON: Then I accept the fact, and I will show what the results of it are.

The CHAIRMAN: You had better keep to the paper.

Commander DAWSON: I will accept the fact that there is a waste in the Naval Reserve amounting to 6¼ per cent. It to me is a very remarkable and most admirable circumstance, that the waste is only 6¼ per cent.

Mr. REDDIE: How do you make out that the waste of 5,000 out of 21,000 is only 6¼ per cent. ?

Commander DAWSON: I make out that the waste of 5,000 in five years, is only at the rate of 1,000 a-year, and that 1,000 out of 16,000 would give a proportion of 6¼ per cent. per annum.

Mr. REDDIE: The 5,000 is the waste during the whole time upon the whole number of men. It is certainly an extraordinary fallacy.

Commander DAWSON: I have no statement but that of the Chairman; I have no figures but those of the Chairman; and it is upon them that I proceed to say, that it appears to me that the waste of the Royal Naval Reserve is remarkably small.

The CHAIRMAN: You have not really got the facts.

Commander DAWSON: I have the facts that I got from you.

The CHAIRMAN: It is not the fact. It is a waste of 5,000 men upon the whole of the men enrolled. There are 21,000 men enrolled, and 5,000 have disappeared.

Commander DAWSON: 5,000 disappeared in five years, I believe.

Admiral RYDER: You may say in seven years.

Commander DAWSON: Knowing something as I do of the deplorable state and condition of the seamen of the mercantile marine, I am astonished that the waste is not greater, because not only is the term of life shorter in the mercantile marine, than in the Royal Navy, but the discipline of the mercantile marine does not correspond with that of the Royal Navy. Secondly, there is a great deal of desertion in the mercantile marine, which is not to be wondered at until things are improved, and that desertion must affect very considerably the Royal Naval Reserve.

Now, with these figures before me, and granting that I made some mistake, or that the Chairman made some mistake in placing the figures before us, and supposing the waste of 6¼ per cent. does exceed that of the Royal Navy, then I think it can exceed it in a small degree. The best way to prevent that waste would be to improve the condition of the merchant seamen. There is also another consideration with reference to this waste. I can well imagine that the persons who were getting up this Reserve had at first little experience of that sort of thing, and may have made mistakes in entering men who would not be entered now; and that the waste of the last five years is no fair representation of the waste that will take place in the next five years. To proceed with the question of efficiency, Admiral Denman, speaking prospectively has asserted that 28 days' drill is insufficient. Now anything from Admiral Denman's pen will receive great respect from the members of this Institution. But it should be remembered that Admiral Denman was speaking theoretically; he was speaking before the formation of this Reserve. I am quite sure that if Admiral Denman were to go on board the training ships, and see these men drilled, he would come to the very same opinion that I have expressed respecting them.

The CHAIRMAN: Admiral Denman, no doubt (and it is fair to make the remark in his absence), considers that the training is far more important than the mere gun drill. You are speaking of the gun drill. Now the training for a man-of-war's man

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is a very different thing from mere gun drill. Admiral Denman was speaking of the whole question.

Commander DAWSON: I am perfectly alive to these circumstances, but I can quite fancy that the Admiral was misled in forming that estimate, perhaps from thinking how 28 days' desultory drill, in the fashion it is conducted on board a sea-going man-of-war would eventuate. It is quite different from 28 days given consecutively, in periods of a week each, in a drill-ship, where there is nothing else to think of. I speak with some little experience of training men, and with all due deference to the Admiral. It may be urged, and I think very fairly, that what is quickly learned is quickly forgotten, and it may be asked, "supposing towards the "end of the year's drill these men were put on board a ship of war, would they be "found efficient?" I think it is a great thing if we can get out of the region of opinion into that of fact. What is the fact now? The experiment was tried very recently with a batch of men returned at the end of a year for their annual drill. They were sent to a gun, and told to secure it without instruction, then and there, as an experiment upon the spot. They secured their gun for sea in a proper seaman-like way. Then they were told to cast loose and prepare the gun for firing, and so on, and I am told they did it exceedingly well, exceedingly efficiently, in a very short time. Now a more serious objection has been raised to the Royal Naval Reserve, and that is to the inadequate numbers, the 16,000. It has been proposed, hardly seriously I should think, to raise the force in the Royal Naval Reserve, by reducing its pecuniary rewards, at page 20 of the pamphlet (see page 297).

The CHAIRMAN: I don't think that is Mr. Reddie's paper.

Commander DAWSON: It is proposed to raise the force of the Royal Naval Reserve at page 20, by *reducing* its attractions from £10 to £4 annually.

Mr. REDDIE: Where?

Commander DAWSON: Mr. Reddie himself, you will see, attaches very little importance to the suggestion; and I certainly do not.

Mr. REDDIE: Where?

Commander DAWSON: You will see it at page 20. I will read it. "We might for "instance have a war rate of wages for A.B.'s in the Navy of £36 per annum, be-"sides seaman-gunner's pay, badge pay, &c., to the more highly qualified men, and "the Naval Reserve men, instead of being subsidized as now, during peace, might "be only paid while under drill." That means to receive £4 a-year instead of £10, to put it into plain language. "And have this prospect of high wages in the Navy, "held out to them during war, and when actually serving, the Reserve being made "the door for entering the Navy." Then, again, a little further down on the same page, "We might limit the number of the paid men in the Reserve to, say 5,000 or "10,000, letting the present number gradually drop to that limit, and in future "enter another 10,000 or 5,000 only as probationary reserve men, without pay, "without any retainers except the pay they would receive while under drill, and "qualifying to get on the paid list." There is an additional qualification to get on the paid list, and in the interim the wages are lowered from £10 to £4. You think to increase the attractions, by *reducing* the pay from £10 to £4. Yet the present attractions appear to be insufficient, as we have got too small a force now. It appears to me that no reduction of expense has been suggested by Mr. Reddie, which would not reduce these numbers instead of increasing them. My suggestion which I made and beg to repeat again is, that the qualifications for entry should be extended so as to include all men serving in fore and aft vessels, and that the term of service should be extended, and by those means we might increase the number of the Reserve. But in doing so, you must increase the expense, and I don't see how you are to avoid it. Another argument is, that the Royal Naval Reserve keeps men out of the Royal Navy, who would otherwise enter it. That has been reiterated by the Chairman also.

The CHAIRMAN: I gave you my authority, viz., Admiral Ryder.

Commander DAWSON: Now I give you my authority. My authority is Mr. Reddie. It appears at page 15 of his paper. It has been already quoted, but I think it will bear reference to again.

The CHAIRMAN: That is Admiral Ryder's, that is not Mr. Reddie's.

Mr. REDDIE: No.

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Commander DAWSON: It appears that in the five years the Royal Naval Reserve has existed, from 1861–62 to 1865–66, there were entered 11,790, of whom 3,961 were pure blue jackets.

Mr. REDDIE: In these five years there were 31,207 men entered, of whom 11,790 were pure blue-jackets.

Commander DAWSON: But I am giving you the benefit.

Mr. REDDIE: But I do not want any benefit.

Commander DAWSON: I will tell you why I am giving you the benefit.

Mr. REDDIE: I don't want the benefit, I want the fact.

Commander DAWSON: I am giving you the fact. The fact is this, there are 7,829 of these men who had previously served in the Navy.

Mr. REDDIE: I have stated so.

Commander DAWSON: Very well, I know you have stated so; they are your own words I am giving. We read in a book by no less an authority than the Duke of Somerset, that for the last four years ships have not had to wait for men. Now Mr. Reddie supplies us with this argument, it is in his own paper, therefore how can we say in the face of that that the Royal Naval Reserve keeps men out? On the contrary, before the Royal Naval Reserve was formed, what was the fact? Why that £10 bounty was given to seamen, in order to induce them to enter the Navy. We have never had to make such additions since the Royal Naval Reserve was formed; on the contrary, we have the words of the Duke of Somerset, and they are worth repeating, that "as for men, during the last four years we have never had to "wait for them." The question is, what is the objection of the merchant seamen to enter the Royal Navy? There is an objection, and it is one that it is very difficult to meet. The best merchant seamen have always objected to entering the Navy, and even when a £10 bounty was offered, the best seamen did not come forward. It was only the trash of the mercantile ports who came forward by thousands. What inducement is held out in this paper greater than the £10 to induce men to enter the Royal Navy? I do not see any sufficient inducement suggested where a £10 bounty failed to attract them. What is their objection? Let us get at that objection. The best merchant seamen hold a very high position with reference to their companions and with reference to their Officers, in their several ships, in which they are looked up to, and respected, and are holding, virtually, almost the position of petty officers. But when the best merchant seamen come to the Navy, they have to begin life again at the bottom of the ladder, and ascend to the top. No doubt if a man comes in young, he might with a little spirit work his way up to the top, and form a very excellent petty officer; but if he comes into the Navy in middle age, say between 25 and 30, the chances are very much against him that he will ever rise. He will find himself in an uncomfortable position and circumstances; and in a lower position than he was in before. That is one ground why the best men will never enter the Navy except under some strong inducements, which we have not yet got. There is another reason why the best men do not enter the Royal Navy, particularly those of the Royal Naval Reserve, who belong generally to the northern ports and who being most respectable men, belong to benefit societies like trades' unions. These societies have a rule, that if a man enters the Royal Navy he will forfeit the whole of the benefit of his deposit. This is an alarming discovery. If this be the fact, then the Government should provide a benefit fund, that is to say, something corresponding to such benefit societies, and allow the men to contribute voluntarily. This would be costless to the Government, and would meet that obstacle which has been raised.

Mr. REDDIE: May I ask whether that rule applies to the Royal Naval Reserve when they are called upon to join the Royal Navy during war?

Captain DAWSON: I do not know.

Mr. REDDIE: Because I think that is very important.

Mr. GRAY: The Act recites that any person having any benefit in a benefit society shall not forfeit that benefit if he join the Royal Naval Reserve. It is an express provision of the Act of Parliament.

Captain SELWYN: Under those circumstances some of the societies have ceased to exist—have been broken up.

Commander DAWSON: A mistake has been made in thinking it necessary to

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destroy one Reserve in order to build up another. That appears to me to be a paramount mistake, because there is room for both Reserves, and for a great many more Reservements. I think Mr. Reddie has made a mistake in not putting forward his Reserve as an additional one rather than as a substitute for the one in existence. This is a somewhat serious mistake. The Admiralty had until recently a very bad name with reference to breaking faith. The traditional policy was supposed to be that of breaking faith with the seamen, and it appears to me, if you were to reverse, in the present generation, what has been done with reference to the Naval Reserve, you would certainly lower the influence of the Admiralty.

The CHAIRMAN: There has been no proposition to that effect.

Commander DAWSON: There has been a proposition either to abolish the Reserve or alter it altogether.

The CHAIRMAN: No, an equitable arrangement, and equity does not mean that.

Commander DAWSON: It appears to me that either to abolish or to seriously alter would be to go back to the system I have condemned. There is one part of the Reserve which has been very mysteriously left out, whether it is that everybody considers it as a useless Reserve, and therefore nobody mentions it. There are the Naval Coast Volunteers. It is a cheap Reserve, it only costs £25,000.

Mr. REDDIE: May I interrupt you? Remember this has nothing to do with manning the Navy.

Commander DAWSON: It has to do with Naval Reserves, inasmuch as these men would be called out if they agree not to chase an enemy beyond 300 miles from the land.

Mr. REDDIE: I have noticed the Reserve merely in reference to manning the Navy.

Commander DAWSON: Manning the Navy is the only thing the Naval Coast Volunteers are enlisted for. As I do not wish to occupy time, I will pass on rapidly. It appears to me that Mr. Reddie's proposal in reference to the Reserve is really taking a retrogressive step. It is going back from the continuous service system, which has been one of the greatest benefits to the Navy in the present generation. To reverse that system would be a very great evil, and would launch us back to the old, bad want of system. We would discharge men at uncertain periods, and then expect them to come into the Reserve, and why? The inducement of £10 is now offered to any man who on leaving the Navy chooses to go into the Royal Naval Reserve. Now, does he enter it? He does not. If joining the Reserve is not to be compulsory what is to be the inducement? If £10 are insufficient, you must give much more than the present sum, and so raise the expense of the Reserve. I do not see how you are to do it without. Another question is, how is this Reserve to be called out in time of peace? It is a very pretty theory, if you can get these men to come voluntarily in peace. There is, I grant, a great difficulty about these "contingent" seamen, and I think we should be very glad if Mr. Reddie's plan would meet the difficulty. Suppose you have these men in the Reserve, how are you to get them back into the Navy? You must take them as they stand on the roster. Say you have 10,000 Reserve, and want a couple of thousands to man the ships. You cannot take them in their order, because half of them may be in the East Indies or in the Pacific. If you call them out *en masse* you can get them, because you send out to the different stations, and capture the men and draft them on board. But, how are you to get them in rotation, in time of peace, without sending out search warrants to search the ships in the different ports, and take the men at an inconvenience to the shipowners? I do not think the shipowners would like these men to man their ships under such conditions. There has been a great question about the Reserve rigging the market against ourselves. Any Reserve will do that, as far as I can see, unless you are prepared, when you call out the Reserve man, to give him his wages in addition to his pension in time of peace. If you do not do that, I do not see how it is possible to form any Reserve that will not, except under some very expensive system, rig the market against ourselves. It is quite evident that the inducements at present to enter the Royal Navy are insufficient, and it appears to me that the inducements that Mr. Reddie has brought forward to induce the merchant seamen to come into the

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Navy are not likely to be much more productive than the present ones, or than that £10 bounty which failed the other day. I will not go into the question of substituting the sort of Reserve that I proposed the other night, of ten years' service men. I am aware that it is open to certain objections; I shall be happy to hear those objections. I have made objections in reference to Mr. Reddie's Reserve, and I shall be glad to hear objections to my Reserve. I only throw it out for the purpose of discussion. My proposal was, that after seamen have served ten years in the Navy, they should be put into a short pensionary service, and that they should receive an additional pension in case they agreed to serve in the merchant service for six months every year. The objection of course will be raised to that, that that must increase the number of boys in the Navy very largely, and it is a question whether ships of war may be safely navigated with so large a number of boys. That is a question open to discussion. It appears to me that there is one great inducement to serve in the Navy, which we might offer to the best class of merchant seamen, that is, if the Government would expend as much money on the seamen's families as, for instance, it expends on the soldiers' families—it has been spoken of in the naval papers for the last few weeks:—if they were to build model lodging-houses at each naval port, for the families of our men-of-war's men during the time they are serving the Queen, and let these to the seamen during that time at a rent which would pay back a fair interest, say of three or four per cent., to the Government for their money, these homes being managed by the Admiralty in all respects, and the sum for them being advanced by the Government. It may seem that the sum would be a very large one; but I think if £50,000 were expended for two or three years—much larger sums are annually expended for soldiers' families (in the Army Estimates you will see it is a much larger sum), and it would be only lent for three or four years instead of being given, as in the Army, absolutely for ever, producing no return; this would be an inducement to steady merchant seamen to come forward and join the Navy, from the fact of their being able to place their wives and families in these homes; and when they left the Navy, from desertion or any other cause, they would have to turn out of these houses. In the meantime, the houses would be paying three or four per cent. to the Government for their money.

The CHAIRMAN: Do you think that is pertinent to the paper?

Commander DAWSON: I am pulling to pieces the inducements which Mr. Reddie has offered, and I think it is only fair that I should propose another inducement.

The CHAIRMAN: But that is not the subject. We shall never get Mr. Reddie's paper discussed. It would be better to read a fresh paper on that subject yourself.

Commander DAWSON: I will not occupy your time any longer.

Captain TOYNBEE, F.R.G.S., Mercantile Marine: I have heard the paper and the discussion upon it with very great interest, and consider it a national subject. I cannot say much for the practicability of Mr. Reddie's system, because it seems to me, to have given it full force it should have been brought forward when there was no Naval Reserve, and when we were going to reduce the Royal Navy. In that case it would, so far as I am able to judge, have been an excellent proposition.

The CHAIRMAN: He is contemplating that, of course, unless the plan be adopted before hand, it could not be applied on any reduction being made.

Captain TOYNBEE: Viewed from the present position of the Royal Navy, it reminds one of the Irishman, who, wishing to lengthen his blanket, cut a piece off the top and sewed it on the bottom. You want a Naval Reserve, and you reduce the Navy, which is now not large enough, in order to make a Reserve, but it has one peculiarity—it is an improvement on Paddy's idea, because after you have bought a piece of blanket and sewed it on—after you have got one Royal Naval Reserve, you are proposing to reduce the Royal Navy, to make another. If you will allow me, I will say a few words on the popularity of the Navy.

The CHAIRMAN: Do not you think that is foreign to the subject? At my request, Mr. Reddie left out the question of discipline, because it would raise questions that were foreign to the subject.

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Mr. REDDIE: I may remind Captain Toynbee, that when I went to the Society of Arts and discussed his paper, I did not wander from the subject.

The CHAIRMAN: It was on the express condition that that question should not be gone into, that Mr. Reddie withdrew that point.

Captain TOYNBEE: I will sit down if you wish, but it seems (if possible) more important to know how to keep first-rate seamen in the Royal Navy than how to get young men to enter. It is said that a certain number of good men are dissatisfied and leave the Navy, and my argument tends to show how that drain may be prevented by making the Navy popular. This subject has been a consideration with several for some time. I believe the popularity, discipline, health, and general improvement of the Navy would be met, if you would do what Captain Dawson has just suggested, that is, consider the wives and families of our seamen. It is astonishing that in a nation with Acts of Parliament now being brought in to improve the dwellings of the working classes, such great employers of labour as the Government, should not set us an example. Social science has advanced far enough to show us that men are what women make them. Woman's influence is known throughout the world; and that woman has two influences is equally well known. Now I think that the sooner we bring about the useful influence of woman the better. She can reduce the doctor's bills; she can reduce the number of days your men spend in the custody of the police, and she can help your chaplains in their good work; or she can do very much to the contrary. I think Christianity and common sense combined—and we profess to be a Christian country—should prompt the Admiralty to build married sailors' homes, and let them to seamen, so as to pay a sufficient amount of interest for the money. They should be placed under the superintendence of a Warrant Officer. To show that I am not speaking contrary to the feeling of the men in the Navy, a friend of mine wrote to a man-of-war now in commission, to ask the chief gunner—one of the best men, I understand, in the Royal Navy at the present time—respecting the subject. Here is a copy of his answer:—"I hasten to reply to your note. I at once saw some of our married "men, and put the question to them. I only wish you had been present to have "witnessed the reply. Nothing that I know of would conduce more to the comfort "and happiness of the seamen than to provide proper accommodation for their "wives and families at a lower rental, such as the Government could afford to do. "One man told me to-day, that at New Passage he pays £6 per annum for one room, "when I feel certain the Government could give him two nice ones for two-thirds of "the money. It is a subject I have frequently talked of, and six years ago I told "Mr. Coram, our Lord of the Manor, that if he would build two or three rows of "small houses, he would soon get them filled by the naval population, for the "Warrant Officers are obliged to go two or three into one house, at enormous rents. "Anything you could say towards obtaining accommodation for the married seamen, "would be deeply appreciated by them." I say it is human nature, that if you want to chain a man to his country, or to keep him steady, you must consider his wife and family.

Captain SELWYN: I had wished to speak further on the subject, but as I know Mr. Reddie has to reply, and it is now already very late, and he has a great deal of attack to answer, I would only beg to lay before the meeting the one thing which appears to me to have been ignored by both parties in this discussion, which is, that the Reserve is not a means of manning the Navy at all. If you want to man the Navy, you must recur to some system like the apprentice system, or you must do something to increase the number of men. Does any one mean to tell me, on looking at the tables, that if one of these sudden European wars which we are at this moment dreading, was to break out in the East, we could raise by any of these wretched devices we have been talking about, the number of seamen, as was done, from 67,000 in 1803, to 147,000 in 1813? It is utterly and totally impossible. The men do not exist. Such men could not be had, if you gave gold for them beyond description. Let us also recollect that no difficulty was felt by the Americans, who manned an enormous fleet by the simple expedient of paying more highly. We have little pennies given for every possible thing; so many that the sailor is perfectly puzzled to calculate what he ought to receive. Give him more wages, and he will allot better, and his wife will get better lodgings.

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Commander P. H. COLOMB, R.N.: I shall crave the indulgence of the meeting for speaking at all, seeing that it is so late; more especially because I was unfortunately prevented from hearing the reading of the paper, or the last discussion. Therefore, it is quite possible I may be saying what has already been said. Still, I think the subject is so important, that perhaps you will pardon me if I detain you for a very few minutes. I notice four chief allegations in the paper. The first appears to be, that equal efficiency in all branches might be more cheaply obtained. Of course that is a very wide question, and I could not attempt to discuss it in any way, except to make the remark, that I think the money spent upon the Navy is not altogether non-productive. I notice as the estimates come round yearly, in the columns of the *Times* and other papers, how the ten millions which are voted, are spoken of as an enormous sum. They want to know where it goes to, &c. I think we should all recollect that as commerce increases, the cost of the Navy necessarily increases, because the commerce of England cannot be carried on except under the wing of Her Majesty's Navy. Therefore I think we cannot come to general questions of expense without mixing up with it the collateral question of the increase of the commerce of England. The second allegation appears to be, that the standing force of the Navy is at present in excess. It is not quite clearly put in the paper, but it appears to me to be insinuated that the standing force of the Navy is now in excess. Now I think that if the standing force of the Navy were now in excess, we should have a surplus of men doing nothing; but it seems quite clear that we have not got them. That seems to be a question of feeling. I think, considering the two points, first of all the enormous increase of our commerce with China, the opening of the ports there and in Japan necessitating an increase of forces in China; and considering the exceptional state of affairs in America, also necessitating there an increase of our force, it would be very difficult to show that the standing force of the Navy is now in excess. The third allegation appears to me to be, that the supply of boys is now sufficient. This first depends, of course, upon what you consider the proper standing force of the Navy; secondly, you must consider it as regards the waste of boys. I am not going into the question of figures. If I had any tendency before I came to this Institution, to be betrayed into entering upon figures, that appalling mass that I see before me would effectually rout my desire. So I am not going into figures; I am only going to say that it is sufficient for my purpose to assert that the waste of boys, from two competent authorities, is given as widely different.

Mr. REDDIE: I will put you right about that. Admiral Ryder and I do not differ about that.

Admiral RYDER: No.

Mr. REDDIE: At all events the Admiral says the waste of boys is nine per cent., and I allow ten per cent.

Admiral RYDER: I take it at less than ten per cent.

Commander COLOMB: Then I must be a little out of order, and ask Admiral Ryder why, if he does not estimate the waste—

The CHAIRMAN: They both agree in principle that the waste of seamen must be kept up by boys. Then the question of waste cannot be determined here; it is a matter of fact.

Commander COLOMB: I will take it this way, to get rid of the question of waste. I will say that two competent authorities say, the one that the supply of boys is sufficient, the other that it is not.

Admiral RYDER: Quite so.

Commander COLOMB: It is quite sufficient for me to know that there are two estimates given, one of which is larger than the other, and both by competent authorities. It is enough for me to assert that the larger estimate must be taken, because if you have made a mistake in your supply of boys, in the training of them, you cannot recover that. If your supply of boys is deficient for any number of years, that number of years remains a gap. Therefore I think that when two authorities, competent to give us information, tell us that in one case the boys are sufficient, and in the other that the number ought to be doubled, we must, as a matter of common sense, take care to re-estimate them. The fourth allegation is that the Reserve is costly, and not of the best. It has been found fault with, that it is not a feeder of the Navy. It

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was quite news to me to read that it ever was supposed to be a feeder of the Navy. I never imagined for a moment that it was intended as such. I thought the Reserve was a specially distinct force, only to be called out in times of trial and danger.

The CHAIRMAN: The allegation is, not that it is not a feeder of the Navy, but that it hinders men from coming into the Navy.

Commander COLOMB: I put it in milder terms, you put it in stronger terms. I say that the Royal Naval Reserve is not a feeder of the Navy; that has been adverted to by Captain Dawson, and I think answered. There is one point which has not been referred to to-night; I am not sure whether it was touched upon in the last discussion; but I think there is one point which we ought to have noticed, and marked very carefully, and that is that we acknowledge that the standing force of the Navy will be a shifting number. Political exigencies will reduce it in times when possibly the majority of Naval Officers will be of opinion that it should not be reduced. But there is this to be said, that when the number of men serving in the permanent Navy is reduced, your Reserve will be at the same time reduced, so that instead of having the comfort and security of a Reserve which does not depend upon political exigencies, you will be depending on a Reserve which these political exigencies may at any moment deprive you of. I think that is a very strong point. I think the Reserve, as a matter of principle, should be kept altogether distinct from and independent of the force of the Navy, which is regulated by Act of Parliament. As regards the overflow, I quite agree with the writer of the paper, and with some of the speakers to-night, who have said that it seems desirable that the overflow from the Navy should be retained. How we are to retain it, is another question. It has been pointed out that if we allow them to go into the merchant service, theoretically we retain them, but practically we do not, because they go abroad, and we do not get them. I should say, putting them into something like the Coast Guard, and drawing them again from that force when they are wanted, would be a more statesmanlike and prudent mode of dealing with the question. There was one assertion also made, that this overflow from the Navy would not require the training which is now required by the Naval Reserve to keep them ready for service; that men who had served from three to five years in the Navy might be discharged into the merchant service, and be ready to serve; and that we would save the cost of a yearly training. Now I do not think that anybody who has had to deal with the men, can believe that they can be kept efficient without something like a yearly training. I do not think you will save that expense. I have only one more remark to make. I noticed a sort of—what shall I call it—a double-breasted apothegm in Mr. Reddie's paper—"Save well during peace that you may pay well during war." It is of a character with some other apothegms of the same description. There is one very well known, that is, "Stuff a cold, and starve a fever," which is exactly a similar thing. The two, unfortunately, as well as being double-breasted, are double-edged. They will attack the person who uses them in a direction which he little expects. "Save well during peace" and you will certainly pay uncommonly well during war. I do not think it is possible for us here at this meeting to give any adhesion to that sentence, with the example before us of America, which was saving uncommonly during peace, and which has now accumulated, during a few years of war, an enormous debt, which it is doubtful they will ever pay, although some people say they will; and, on the other hand, of Prussia, which did not save well during peace, but expended a proper and judicious amount upon her war forces, and was able, in a short campaign, to do everything that she wished to do, and is now clear of debt.

Mr. WHITEHEAD, Registrar-General of Seamen's Office: The course which this discussion has taken must be, I think, eminently gratifying to the numerous supporters of the Royal Naval Reserve; and none have more cause than they have to join in the vote of thanks to the hon. gentleman who originated the discussion. Any one who may have come into this room and listened to the debate, without having listened to or read the paper which gave rise to it, might have supposed that this meeting had assembled for no other purpose than to glorify the Royal Naval Reserve, so ample has been the praise bestowed upon it. It is not every Institution which has the advantage of being so publicly lauded as the Royal Naval

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Reserve, or of receiving those encomiums that it has received here, which, coming from gentlemen of high official standing as well as practical experience, entitles their opinions to the greatest credit. But the gratitude which the Royal Naval Reserve supporters for this reason undoubtedly feel towards the hon. gentleman, is considerably tinged with a feeling of indignation when they reflect upon the injury which might have been done to an admirable institution had these statements which the gentleman has so laboriously compiled, been permitted to go forth without question. It is a pleasant thing to know that these statements have not been promulgated by an unseen hand; and we may safely surmise that, if not exclusively confined to the hon. gentleman himself, they are shared by a small coterie of gentlemen whose policy is obstructive, and who are as weak in numbers as— (Order, order.) I wish more particularly to refer to three points which the hon. gentleman has raised in objecting to the Royal Naval Reserve. The first rests upon a combination of figures whereby he has endeavoured to enlighten us as to his notion of matters of public economy, and the two others rest upon his assertions, which are not supported by facts, and which are contrary to reason and experience. In fact, some of his assertions contain such extraordinary mis-statements, such disregard of events which must be perfectly well known to every one who has had the least to do with the Reserve, that I can only account for it on a theory, which may be as startling as some of the gentleman's own statements, viz., that I believe he must be an ardent admirer of the Naval Reserve.

The CHAIRMAN: You are really not speaking to the paper. Your remarks are personal, instead of being to the point.

A VISITOR: If the Chairman would only bear in mind that every time he interrupts a public speaker he knocks the breath out of him. If I were a speaker, I would call upon the audience to support me.

Mr. WHITEHEAD: The three points I wish to draw attention to are, first, the objection the gentleman has raised to the Naval Reserve on the score of expense. This is a financial argument. The other is an objection he has raised, in saying that it keeps men from joining the Navy. And the third is the imputation cast upon the men of the Reserve themselves, that they will not be found available when wanted.

The CHAIRMAN: There is no such statement in the paper.

Mr. WHITEHEAD: I think there is.

The CHAIRMAN: I beg your pardon; it is not so asserted at all.

Mr. WHITEHEAD: The words in the paper are, that they may be "backward in coming forward," and that means, if it means anything at all, that they will not be found available when wanted.

The CHAIRMAN: Will you speak to the point?

Mr. WHITEHEAD: One of his objections is on the score of expense.

The CHAIRMAN: Then will you speak to the actual question of expense, and not go off into abstractions?

Mr. WHITEHEAD: It is the Lecturer's objection to the Reserve, on the score of expense, that I wish to do away with. I think the Admiralty ought to feel it a very gratifying fact that they can have a force of 16,000 men, well trained, well drilled, and able in all respects to take their station on board a man-of-war, when called upon in case of need. These men are not common ordinary men that you can pick up in the streets, the highways, and bye-ways. Some of these men are, in point of *physique*, superior to the men in the Navy.

The CHAIRMAN: There has been no question of that kind raised—no question of character.

Mr. WHITEHEAD: The hon. gentleman has thrown an imputation upon the men of the Reserve, and I merely proceed to show that they are a valuable body of men. Men who have been rejected for the Reserve, it is a well-known fact, have afterwards been admitted into the ranks of the Royal Navy. It ought to be a gratifying thing to the Admiralty to have a force of 16,000 men, well drilled, and well trained, ready in time of need for any emergency. They ought to feel it a gratifying fact, because they cannot get such seamen as these anywhere. Able seamen are not like poets. Every one knows, *non fit, poeta nascitur*. But the able seaman, on the other hand, is not born an able seaman, but must be formed by years of toil, and by years

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of apprenticeship to his profession before he can take his rank as an A.B. The hon. gentleman says these men will not be found available when they are wanted. This imputation has been already handled by those gentlemen who have a better acquaintance with the seamen than I can possibly have.

The CHAIRMAN: All this is quite foreign to the paper.

Mr. GRAY: If Mr. Reddie says that the Reserve men will be backwards in coming forwards, I submit, under correction, that it is the duty of every man who thinks otherwise to controvert that assertion as strongly as he can.

Mr. REDDIE: Mr. Reddie has not said so.

Mr. GRAY: Mr. Reddie has said so. He has said the seamen are backward in coming forward.

Mr. REDDIE: Mr. Gray is stating what is not correct.

Mr. GRAY: Will you read the passage?

Mr. REDDIE: No; I leave myself in the hands of the Chairman.

The CHAIRMAN: I say this is perfectly foreign to the subject, and as it is now ten minutes to ten, I will now call on Mr. Reddie to answer the objections that have been raised.

Mr. REDDIE: I shall not pretend in the least degree to reply to the remarks of the last speaker. I think they will not be of any disadvantage to me, when his speech comes to be read alongside my reply, although I have taken no notice of it. I shall proceed to notice a few of those remarks that have been made this evening, that are worth replying to, while they are fresh in my memory. With reference to what Captain Colomb said last, about saving well during peace, in order to pay well during war, if I am wrong in supposing that the Landwehr is not an expensive force, he has made a point against me, and I think the only one. As regards the yearly training of the Reserve that I propose, as not being possibly dispensed with, I can only say that the men of the French *Inscription Maritime* are not drilled in this way. I believe, in reckoning the comparative forces of the Reserves of the two countries, the whole 90,000 seamen that form the mercantile marine of France, as against our 350,000, are generally reckoned as all able seamen, from their admirable system which passes their seamen from their Navy into the Reserve. With reference to Captain Selwyn's remarks, I must point out, as I have done already in my paper, that any increase in the number of boys you like to train for the Navy, will never enable you to swell your force suddenly. You may train a large number of boys if you choose; and Admiral Ryder, who has proposed that, in the voluminous papers which he told you he has laid before successive Boards of the Admiralty, has not only seen that the consequence would be that he would have a large excess of seamen, but he has actually told us how you may get rid of them when they grow up. If you enter a large number of boys annually, they will grow up whether you will or no; and if you want to increase your men by 20,000 or 30,000, you could not get them out of the boys. When you had that large force of 147,000 seamen in 1813, you had no boys at all, and that force was then drawn from the comparatively small mercantile marine of this country.

Admiral RYDER: No boys?

Mr. REDDIE: No boys in 1813.

Captain SELWYN: It is quite a mistake.

Admiral RYDER: I thought there were powder boys on board ship.

Captain SELWYN: Pardon me, Mr. Reddie, for just correcting you. I do not think you quite comprehend what I said. I did not propose increasing the boys, but increasing the whole number of seamen available for the Navy.

Mr. REDDIE: Admiral Ryder spoke of increasing the number of boys. I think Captain Selwyn answered very wittily Captain Toynbee's and Captain Dawson's Utopian proposition to build cottages for our seamen. Really those philanthropic views are not practicable. If men were in office, and had to get money from Parliament, they would find the difficulty of it; and, moreover, if they had as much experience as Admiral Ryder has of Government cottages (which we have to a very great extent already in the Coast Guard), they would scarcely, if they were men of business at all, think of putting forward such a proposition, which I might almost term preposterous—

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Captain TOYNBEE: I mean the model lodging-houses, such as Waterlow's Buildings; they pay 5, and even 10 per cent.

Mr. REDDIE: I beg leave, after three nights' discussion, to be now allowed to reply. As I have reminded you, in the Society of Arts discussion, I did not wander from the subject. I now come to Captain Dawson. He had some difficulty to know how to get the Reserve men to go into the Navy upon my proposition. He apparently overlooked what is plainly put into the paper, that a part of my plan is, to make the Naval Service preferred. It is a course I have long advocated, and it is a course advocated in the admirable book, which is attributed to Admiral Denman. The moment you do that, there will be no difficulty in getting your men back. And it is part of my plan also—which appears to be overlooked by those gentlemen who have been so very quick in speaking upon it, but do not seem to have studied it much—a part of my plan is, that the retainers should be what the men receive for, say, good conduct badges, and other special qualifications, and for these they would take the pay with them, whether they went into the Reserve, or into the Navy. So I think there is no difficulty at all, by my plan, of engaging men to return to the Navy when you want them. Captain Dawson says, which is a very important fact, if it be a fact, that our men, the Navy men, do not go into the Reserve. I was indeed thinking that that was perhaps a redeeming point, as regards this Reserve of 16,000, that probably a considerable number of them were men-of-war's men, who, even if they had not the benefit of an annual training, when they found themselves again in a ship of war, would have been ready to take their places at the guns, and do, after years of experience, what this gentleman tells us they can do after 28 days' training, when taken from the mercantile marine. Then, with regard to the Royal Naval Volunteers, I was sorry to interrupt Captain Dawson about them; but the reason I did so was, that they have never been regarded except as men to be called out "upon an emergency." I should not have mentioned the Naval Reserve at all, had it not been that I wished to propose a plan which would enable you to man your Navy in peace as well as in war, and not merely in an emergency. I should mention that when Sir William Parker's committee was formed, in 1852, what was remitted to the committee to enquire into was, the best mode of manning the Navy in peace as well as during war. Admiral Ryder's statement (which has been repeated even after it has been corrected—and in ignorance attributed to me) that the Reserve does stop the manning of the Navy—is very serious and important. I think I have pointed out that this was quite contrary to the intention of the Board of Admiralty, who instituted the Reserve, by taking the tenor of the remarks in this pamphlet upon *Naval Expenditure;* and I cannot understand in the slightest degree those expressions of Captain Dawson's about "breaking down the wall of partition" between the two services; which phrascology I find he has copied from the gallant Admiral, who tells us in a pamphlet, a copy of which he was good enough to send me, that the "partition wall" between the two services is broken down by this Reserve;—as it appears that though that "partition wall" is broken down, there is still, upon the very theory of these gentlemen, to be a great gulf fixed between the two services. As Mr. Gray put it, in a very plain and business-like manner, which came well from a gentleman from the Board of Trade.

Mr. GRAY: I object to that statement, as I do not represent the Board of Trade.

Mr. REDDIE: Perhaps so; but I repeat it came well from a gentleman from the Board of Trade that the merchant seamen were to take their retainers, and we were to keep our men. As regards Captain Dawson's estimate of the waste, I am almost sorry for him that he should make out that 5,000 taken out of 21,000 is only six per cent.

Admiral RYDER: In the year.

Mr. REDDIE: Never mind that. This waste is taken upon the gross numbers of men in all the years, and the percentage is the same. If you take the numbers you had in 1861, and take the waste upon that, you will not find that you had then 21,000 men to deal with. I will, however, leave that. If Captain Dawson is content to have his estimate stand, of course it must stand. The reporters are great men in a discussion, and some will begin to repent of the things they have said in this

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Institution bye and bye. Then Captain Dawson is under one misapprehension, which I think I can clear up. He told us that we required to give a bounty to get men in 1859; and that, before that, we could not get them. I am very anxious that Admiral Ryder especially should understand the facts of the case. This is a return that has been in his hands much more than it has been in mine.

Admiral RYDER: What is the heading of it?

Mr. REDDIE: It is "The Waste of the Navy," a paper with which you are well acquainted. It is a return that I have always placed at your disposal, and which you have gone frequently over, but which you do not appear to have mastered. I am therefore anxious that you should keep in mind some facts that are in it. And as Captain Dawson seems to have had the benefit of your views——

Admiral RYDER: I beg to say that nothing has passed from me to Captain Dawson on the subject.

Mr. REDDIE: I only say it seems so. I dare say I am mistaken.

Admiral RYDER: You are mistaken.

Mr. REDDIE: It is a trifling point if it were so, but I want to point out that in 1858-59, 4,365 men joined the Navy as "first entries," and of these 3,504 were pure blue jackets, and consequently came from merchant ships. That was before we gave a bounty. The next year when the bounty was paid, we entered 11,600 men, of whom 9,976, or in round numbers 10,000, were blue jackets.

Commander COLOMB: What was the reduction of the Navy the year before?

Mr. REDDIE: There was no reduction in the year before. I am speaking of the first entries.

The CHAIRMAN: You have got the return: it is "First entry."

Mr. REDDIE: I think I have now disposed of every point of importance that I recollect this evening. I have not noticed the eloquence of Mr. Wood, because I did not quite see how it bore on what I said. However, he will have the benefit of it all in print, and those who read my paper will have the advantage of reading his remarks. I shall now proceed to take the previous discussions. I am sorry to say we have not got last night's discussion in print, but I have got the first, at all events, and I think I have a tolerable recollection of the second. I will take the speakers as well as I can *seriatim*. Admiral Ryder, you will recollect, moved the adjournment of the discussion, and with that great discretion which no doubt distinguishes him, he reserved his fire. Captain Dawson, however, would tell us of the admirable training that the Naval Reserve had undergone, though he said they did not fire their guns in the "fly-away style" of men-of-war's men. But he opened fire upon me in a very "fly-away style." And not content with opening fire here, I find he had been opening fire before in *Fraser's Magazine*. He was kind enough to tell me of it, but I have had no time to read his paper; and after that he opened fire last week in the *Hampshire Telegraph*, on the same subject; and he has again spoken to-night. But he always, as far as I can see, fires in a different direction. It is such loose practice coming from a gunnery officer, that I do not know very well what to make of it; as such loose shot cannot all hit. Several of them have fallen short; several of them have gone over my head. I do, however, find that one shot hits my paper, that is absolutely to approve of it. He is very fond of Reserves; I do not know how many he wants, but he thinks I have brought forward one very good suggestion to supply a part of his Reserves. Why I do not propose that as a Reserve, only along with some others, is because I am quite certain that if you have a real Reserve, such as they have in France, of men afloat, or such a Reserve on shore as they have in Prussia, no statesman who has the management of the affairs of the Admiralty, and no Commander-in-Chief, would ever wish to have a Reserve of less qualified men:—he would never turn from men-of-war's men to any other class of sailors. I say this without depreciating the character of the merchant seamen, which I beg leave to say I have not done in the slightest degree, or in any manner, in my paper. He thinks that the proposition that I have made, to secure a Reserve to fall back upon in case of a sudden maritime struggle, will not meet the requirements of the case. That shot, I think, falls short of me, for I do not know that I restricted the Reserve to any number. The difficulty I should have, as I

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shall hereafter show when I come to Admiral Ryder's figures, would be rather to restrict the amount of the Reserve, than to get it up to 16,000. Of course, as I have said, the breaking down of the "wall of partition" seems merely a way of talking about the thing; for in Captain Dawson's speech on the first night, he had scarcely expressed himself in these terms, when he went on to say that according to his mode of manning the Navy, he would never require to get men from the merchant service! Therefore, we might just as well have the wall up as have it down, if we are not to get men from the merchant service. These are contradictions which I cannot understand; and I think when people come to study these things a little more calmly than they have managed to do in this Institution on this occasion, they will perhaps change their opinions upon some of these points. But there is one other point in Captain Dawson's speech the first evening, which I shall notice, for I reserve his difficulties about the merchant seamen until I come to deal with Mr. Gray, who is perhaps more responsible for those figures, as to which he interfered to correct me. I come now to the last point in Captain Dawson's speech. He wishes the Reserve to be three times its present size. He wishes that we had not only 16,000 men, but 48,000 men; and what is his reason? His reason is: "We might, perhaps"—he speaks, you observe, with very great caution—"we "might, *perhaps*, be able to lay our hands on 30,000 or 40,000 in case of war." This is very much like the loss we have got here between the 21,000 and the 16,000. You are to have 48,000, and *perhaps* you may be able to lay your hands on 30,000 or 40,000 of them! I do not know whether these gentlemen, who have been accusing me of attacking the merchant seamen, will also attack the gallant Captain. —I am quite sure if they do, they will have a volley in return, "For (he adds) we "must allow a large margin for persons whom we could not get"—a margin of between 8 and 18 thousand!—

Commander DAWSON: Sickness must be allowed for.

Mr. REDDIE: Well, about sickness in the Naval Reserve, if we remember that a Volunteer must be a British subject, free from infirmity, under thirty years of age, I must say that the failures on account of sickness, that result in death are very large—frightfully large. Then we have to deduct for men who have joined the Navy 473; and for men discharged 953. Both he and Admiral Ryder speak of weeding this Reserve, and you see it has been weeded. Then there is the number who have died—no less than 1,523; and then there are the men who took their retainers for a time, and never come back, 2,285;—Total waste, 5,234.

Admiral RYDER: In seven years?

Mr. REDDIE: How many had you seven years ago in the Reserve?

Admiral RYDER: None.

Mr. REDDIE: Just so. Six years ago you had not 3,000. It is within much less than five years that the bulk of these men have been enrolled, and gone from you. It is no use trying to blind the eyes of any one about this question. It is quite clear that nothing could be done upon my paper, and still less upon any speech delivered here, without a thorough inquiry by competent persons. It is quite clear from the whole tenor of my paper that I never thought of anything else; therefore, I have been the more surprised at the extraordinary tone that has distinguished many of the speakers throughout. I now come to the Chairman.

Commander DAWSON: Before you leave me, would you allow me to say that nothing personal to yourself has been said by me?

Mr. REDDIE: The Chairman's remarks I need not go into, for, on the whole, I do not think he had an opportunity of going into the full scope of the question. As he put it, he was rather favourable to my views. Then I come to my friend Captain Selwyn. His remarks to-night I have already replied to. His remarks on a former occasion were also like Captain Dawson's, somewhat in a "fly-away style," if he will excuse my saying so. He had written an article in the "Nautical Magazine" some six years ago, and he thought proper to read it. It is all in print, so that if what I say regarding it, is not justified, it will be quite clear that it is not; and those who read the report, can read the gallant Captain's remarks, along with my few words of comment. I should call his system a mode of "dismanning the Navy." It was to scatter men anywhere and everywhere over the world; it was to be nothing but a

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system of discharging. The men were to go, and they were to come back, and they were to find purses, and money was to be paid them; and if they came back, well, and if not, never mind. Having discharged all his men but one, a warrant officer with a grievance; he blew him away as he fired his last gun at a target of foolscap and red tape. I should not have noticed this at all, if it had not related to an office with which I am *not* connected. If he will permit me to indulge in a little *esprit de corps*, I may say that I am quite certain that this grievance must have been refused a hearing, *if it was refused a hearing* at Whitehall; and I think it a pity that Naval Officers should come here with such idle tales of grievances; which is only upon a level with Captain Toynbee's reading the opinion of an individual gunner to tell us how to man the Navy. How does he know how to man the Navy? It is trifling with the question; Captain Selwyn will forgive me saying so, for there is no man in this Institution whom I usually listen to with greater respect. But I am now on my defence, and I am sure he would not like to see me with my hands tied, and not able to give shot for shot. I might also say, with regard to this red tape and foolscap, that although my antecedents were gone into in a very strange manner the other night, my antecedents in connection with the Navy were not gone into. There is not, perhaps, any man who can more freely appeal to the Naval Officers in this country, as one who is known to be not much given to red tape, and who likes *foolscap* still less. But the Captain wound up with a very curious remark, making an antithesis between statistics and facts, as if any statistics that were of the slightest value could be inconsistent with facts. It may be true that statistics may be abused, and may be little understood. I am afraid when I go a little further in answering the objections that have been urged to my paper, or in noticing the views that have been advanced against it, I shall be obliged to point out how statistics may be very curiously handled indeed. Still statistics so far are facts. As regards those figures, of course you perceive they out-number mine tenfold. In fact, with regard to those figures of mine, there has been no argument advanced bearing upon them. I come now to the Admiral's figures. You will all recollect how he spoke of the pouring out of the men—the continuous service men and the non-continuous service men—pouring out of the fleet. In that he was quite correct, and what he vaguely, although in strongish language asserted, I will give you figures to confirm. I am still confining all this discussion of figures to the last five years which the Admiral himself has chosen. Previous to that, we were increasing the Navy, and the state of things was very different. Since then, we have been reducing it. I do not want to make out a strong case, and I confine myself to the five years when the Admiral was at Spring Gardens, and knows something about it. Well, Sir, the waste of seamen according to our estimate of waste in Somerset House, from casualties that cannot be controlled, was in those five years, 23,985 men. We call that a waste of ten per cent., but the men paid off to the shore in the same period—I take this from the statement which has been in Admiral Ryder's hands longer than it has been in mine—the waste, as he called it, of men paid off in the same period, was no less than 29,182.* Then if I am right in calling that 23,985 a waste of ten per cent., and if I were to add another waste equal to 29,182, I should not say the waste was 14 per cent., but upwards of 20 per cent. At all events those two round sums of men who left the Navy in those five years amount to 53,167. I am speaking here merely of seamen—of seamen only, not marines, not boys, not Officers. But, Sir, unless a man were a bottle conjurer, and could go on pouring out and pouring out, it is quite clear that if 53,167 men left the Navy in that time, and we have a Navy still in existence, there must have been men coming in. I shall be very precise in letting you get to the whole bottom of this mystery of "pouring out." On the first of April, 1861, we had 43,022 of these seamen. We entered (as you will find at page 15 (292) of my paper), during that period from the 1st of April, 1861 up to the 31st March, 1866, a period of five years, 31,207 men, and we grew out of our boys—*i.e.*—we rated boys as men—to the extent of 12,247. That makes a total of 86,476 men; and when you abate from that, the 53,167 that I have told you of—the 23,000

* *Vide* TABLE II, appendix A., p. 356.

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who died, deserted, or slipped through our fingers through casualties, and the 29,000 odd, that were discharged to the shore and paid off—when you have allowed for these, you have 33,309 seamen remaining, which was precisely the number we had in Her Majesty's ships on the 31st March, 1866. Now there is no occasion, in my opinion, for any of these complicated tables. I have given you in simple numbers the main result. I will say with regard to those statistics that I got them from precisely the same source as Admiral Ryder. They are not picked out by me individually from the ship's books. I have a valuable staff of gentlemen in one branch of my office, under the superintendence of one of the most able and conscientious public servants that I believe we have under Her Majesty: I speak of Mr. Crawfurd Harrison; and he and his valuable staff have supplied those figures to us. I think the Admiral should not be so tender about my questioning his tables, nor should he be so pertinacious, as if we had short memories, in telling us that his figures up to a certain extent were checked in our department. There is no doubt about that. But all these figures were not checked, for these are his workings and his deductions, from the simple figures we gave him. I think there was no man here last evening who understood in the slightest degree, what Admiral Ryder meant when he alleged, that we could not get men to enter the Navy to any great extent, while he told us they were always pouring out. I must say that I think there was not a single person present, except the Admiral himself and Mr. Gray (who said that all that Admiral Ryder said, he was prepared to say), who understood how it was possible we could have a Navy existing, and still require £4,000,000 to pay their wages and their victuals, if the men were always pouring out and none were coming in. Well, thus far, I have been speaking of the Navy as a whole; but there was a more specific point that the gallant Admiral brought forward, not for the first time, as regards the entry of seamen. The gallant Admiral called at my office, after it was settled that I was to read a paper on "Manning the Navy" at this Institution.

Admiral RYDER: Pardon me, I was not a party to that, for I did not hear of it till afterwards.

Mr. REDDIE: He came and discussed those statistics, and he told me, in the presence of a gentleman in my office—the gentleman who supplied him with the figures from which he has worked out his tables—he told me of my ignorance in not knowing that he had been unable, as Comptroller of the Coast Guard, to enter men. Now, it was no part of my business to know that the Admiral had orders to enter men and could not do it. An order of that kind comes to my office, and it is noted there, but as I have not to manage the entry of the men, when he told me this, I very good-naturedly replied to him, pointing to those men shown in the table at page 15 (292) of my paper, that if he was not fortunate enough to get men, other Officers could. Well, you will find in the years 1866–7 the seamen voted were 37,300, and the Coast Guard afloat 2,614. If you add these together (and it is not a very hard sum) and divide by 2,614, you will find the Coast Guard forms no large proportion—only a fifteenth part of the whole number afloat! That will explain to you why I did not go into particulars whether a fifteenth part had got men, and whether the whole 31,000 had been got in the other ships. But I may also say that out of the 31,000 that entered at that time, if the Coast Guard had only done its fair share, and entered a fifteenth part of the 31,207, the ships under the gallant Admiral's command (although you are aware he was not in the ships, but at Spring Gardens) should have supplied 2,080 men, out of the whole number. And how many did he supply? He supplied no less than 2,631.

Admiral RYDER: Of pure blue jackets?

Mr. REDDIE: The Admiral, I have told you, entered 2,631 men, or 551 men more than his proper share, in proportion to the rest of Her Majesty's ships, and curiously enough he entered 552 pure blue jackets, and not only 552 of these pure blue jackets altogether, but men direct from merchant ships (first entry men in addition to 709 pure blue jackets, old men-of-war's men. That is my reply, Sir, to the charge of ignorance (now publicly repeated here) as regards the entries of seamen in the Coast Guard ships under the control of the gallant Admiral. I come now to one very important branch of the subject. I might have noticed

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some more of the gallant Admiral's remarks, but I will not say anything more about them, because I think I have sufficiently shown by those facts that they are very confused figures that he has put before you. I might mention before I go on to another part of the subject, that the present number of seamen in the fleet is 36,790, just about 500 under the vote, and about 200 under the vote from the 1st of April next.

Admiral RYDER: Pure blue jackets?

Mr. REDDIE: Not pure blue jackets.

Admiral RYDER: Perhaps you will distinguish between the two?

Mr. REDDIE: In this paper I have given the seamen of all classes, and not usually distinguished pure blue jackets; only when I say pure blue jackets, I mean pure blue jackets. In discussing this question, you must remember that the other seamen are in their places on board ship just as necessary as them, and these constant interruptions are really uncalled for. During the course of Mr. Gray's remarks, both on the first evening, when he interrupted Captain Dawson to put us right about figures, and to-night, he stated that the numbers of seamen, or rather the numbers forming the crews of the merchant navy were considerably less than what I had stated.

Mr. GRAY: What I said was, that the crews available in the United Kingdom were under that number. I presume you did not catch the point.

Mr. REDDIE: The first evening I think you said they numbered only 197,643.

Mr. GRAY: I wish to say that what you say is a mistake.

Mr. REDDIE: I hope Mr. Gray has now said what he wants to say; I can then go on. Very well, the 350,000 which I took from the Board of Trade returns included, as I am perfectly aware, men and boys in registered vessels belonging to the United Kingdom, to the Channel Islands, the Isle of Man, and to the British dependencies abroad. I don't know where Mr. Gray got the exact sum 197,643, but it is of very little consequence. I have the Board of Trade returns here. I find he has taken 1865, instead of last year, but that is exclusive of river steamers. I find from the Board of Trade returns that we have 350,000 men in the registered vessels altogether, and 199,736 belong to England alone, excluding Scotland, excluding Ireland, excluding Guernsey and Jersey, where we have actually a training ship, and excluding the Isle of Man. If you take all these in, and I don't know why these are to be severed, there are 255,654 men; and in the British possessions abroad there are 94,369. I think it shows how small a view of a very large question may be taken, when a gentleman from the Board of Trade comes here and wishes to exclude from consideration, as valueless with reference to this subject, the 94,000 who are in these vessels abroad. These crews of vessels are in vessels belonging to a great extent to the North American colonies. In Nova Scotia and Prince Edward's Island alone there are about 20,000, and in Newfoundland and Canada (Quebec and Montreal) and New Brunswick, more than 20,000 besides. That is 40,000 of them in the North American Colonies; and if we had had a brush with America; I should like to know whether men drawn from these vessels to aid the men required in the fleet, would not have been much more valuable than men at home?

The CHAIRMAN: And more available.

Mr. REDDIE: More available, and therefore much more valuable. Moreover they are very excellent seamen, I am told. The commerce of England is dispersed all over the world, and there are 17,000 or 18,000 of those crews of merchant vessels in India, and more if we include Ceylon. There are about 10,000 or 11,000 in Australia. You know the Australians are to have a ship of war sent to them, and quite recognise that they are one with us as regards the defence of the kingdom. Well, Sir, that alone, I think, is worthy of consideration; and, as I have already stated, even if you reduce those men by any vanishing process you may choose—something like this fluxional drain which Admiral Ryder has applied to the fleet.

Admiral RYDER: I did not go into fluxions at all.

Mr. REDDIE: Mr. Gray in like manner reduced the able seamen of the merchant service to 72,000, and he did so apparently with papers in his hand; and yet, with the same paper in my hand, where he gets 72,000 able seamen, I get 13,500 petty officers belonging to the same service, and I get in the adjoining line 18,000 ordinary

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seamen, to say nothing of the engineers, boys, stokers, and firemen—and I do not know what we should do in steamers without them. In fact there has been an attempt to minify our mercantile resources, and therefore by comparison, I suppose, to magnify the numbers of the Royal Naval Reserve. But even this 350,000 comes short of the mark: they are only the crews of *registered vessels*, and I believe if you have a proper system of manning the Navy, and a proper system of attracting the seafaring population of this great country, you may be able to draw from your shores other men besides the crews of registered vessels,—men who have got sea-legs, and men who, very shortly, would be made, under the training they would receive on board Her Majesty's ships, first ordinary and then able seamen. That being the case, I think it would be almost a discredit to this country if we could not avail ourselves of those large numbers—this enormous foundation for a reserve which we possess;—and it is no mere opinion of mine to say, that the mercantile marine should form the basis of our reserves, the basis of our safety as a nation. The same opinions have been expressed (I grant you it is some time ago) by the gallant Admiral in a paper published in combination with Mr. Graves, the member for Liverpool, in 1860; and, in fact, throughout the Manning Committee's Blue Book of 1852, and the Manning Commission's Blue Book in 1859, you will find that completely recognised. Now, Sir, I think I have pretty nearly answered all the pertinent objections that have been raised to my paper. I do not recollect any point that requires clearing up that I have not touched on. I had the pleasure, a few weeks ago, of congratulating Mr. Gray—

The CHAIRMAN: Mr. Gray spoke in a jocular way.

Mr. REDDIE: Well, I shall be good tempered with him, and as jocular as you like. I had the pleasure of congratulating him, I say, on his well-deserved promotion, and I should have been quite glad to see him here "bearing his blushing honours thick upon him;" but I must say it is strong language to use to a gentleman who comes here to read a paper in this Institution, to tell him that his propositions are "monstrous;" to tell him that he is throwing out a suggestion of a sinister kind to the Naval Reserve, and a threat to the Naval Reserve; and when a gentleman stands there and says he blushes for me—

Mr. GRAY: I did not use the word "sinister," and I did not blush in that sense.

Mr. REDDIE: *You* did not make the charge of the sinister "suggestion" and "threat," but you did use the word "blush."

Mr. GRAY: Not in that sense. I blushed for you.

Mr. REDDIE: I can only say he quoted the war cry of an English monarch, but I think, with the sentiment of Shylock, he exclaimed that the Reserve would stick by their bond—that the men had made a good bargain, and would stick to it. I proposed a more equitable thing, which I believe the Naval Reserve men would be most anxious to adopt. I believe they would be ashamed to belong to a reserve on terms which it was proved would prevent their entering the Navy. Their very conduct on the occasion of the "Trent" affair, as volunteers, shows that they are better than their volunteer defenders. No, says Mr. Gray, they shall have their £6 of cash! And I find in to-day's *Times* there seems to be a similar charge against the Board of Trade by a writer under the signature of "Beta," who says that the Board hold to the Act of Parliament with regard to the unpaid wages of seamen, as Mr. Gray would hold to his bond with regard to this retaining fee.

Mr. GRAY: Is that your paper?

Mr. REDDIE: It is in reply to what you stated. In conclusion, Sir, I will say that I brought forward this paper with the view of devising the best means in my power for preventing a great evil which was either imminent or had actually occurred through the institution of the Reserve. Admiral Ryder had stated that it has actually occurred. I never mentioned his name, and I alluded to his statement in the most delicate manner imaginable. I merely alluded to the fact that some people consider that the Reserve is stopping the entry of seamen into the fleet; but, in justice, I also pointed to the entry of 31,000 seamen during that period. But when I did so, I was not at all myself without apprehension, and I stated so in the paper, that although we have got men hitherto, we might not get them so readily

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hereafter. And I will tell you what so far justifies this opinion. It will be found in the table (p. 292), which is a very valuable table, short as it is, if it is conned and considered carefully—you will find that while we entered 31,000 during that period, including, in round numbers, 12,000 blue jackets, the number of blue jackets entered as "first entries" from merchant ships last year was only 485, whereas in 1861-62 it was 1,414. And I find in going back in our statistics, that we have generally had about as many first entries of pure blue jackets as of men who had served—old men-of-war's men—but that has not been the case last year, because then we only had 485 as against 1,136 old men-of-war's men. You will see that the number is diminishing, whereas of seamen of all classes we are getting the same number. It has been told you also to-night that men who have been rejected by the Reserve as not good enough, have actually gone to the Royal Navy afterwards. Now, Sir, I think that a very serious matter. I cannot understand how any gentleman, with professions of patriotism, or a desire to see the Navy of England what it ought to be, can consider it satisfactory, that the Queen's ships should have the refuse of the merchant service! I say we should have the pick of the merchant service; and yet not with the view of robbing the merchant service, but of enriching it. What I propose is, that men who are not, at all events, well-qualified, should come to us during peace, when we have time for that sort of work, and be qualified; and, after they are qualified, by serving in a Queen's ship for three or five years, as they do in France—where they manage things better than we do here—then we shall turn them over to the merchant service, giving them (and I think very properly), if they will engage to come back when we want them, a certain "retainer," as represented by their qualifications, say as seamen-gunners and good-conduct men. They will take those qualifications with them as standing benefits into the merchant service, and keep them, of course, and earn fresh laurels when they come back to us. I certainly see nothing in this proposition to excite the ire of any class of men, whether they belong to the commercial marine or the Royal Navy. I am quite sure of this—and I wrote it in 1860, before the Naval Reserve was in operation—that the merchant ships cannot wish to be manned till the Navy secures them upon the sea. Therefore, our having a Naval Reserve upon this principle, both gives you a larger number of well-trained seamen, for the merchant service, and it gives you security upon the ocean. At this late hour I must say no more. I must thank you for the kind way in which you have heard me. There has been a little smart firing, but I think, when the paper and the discussion come to be read, that I have nothing to be ashamed of.

The CHAIRMAN: I will not take up your time in making any further remarks, but I will make only one remark upon an observation of Mr. Gray's, that I do not think when he was reducing the number of seamen from 350,000 to 70,000, he saw the force of. Now, if it be really so, that instead of having 350,000 seamen to draw our contingent reserve from, we have only 70,000, it becomes a very serious matter, and a double reason why we should have a reserve to provide for those contingent forces, and not one which will provide only in case of a declaration of war. I am sure you will allow me to thank Mr. Reddie for his paper.

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[Mr. Reddie.]

APPENDIX A., TABLE II., referred to on page 351.

Year.	Seamen Rated from Boys trained in Royal Navy.		"Waste" of Seamen from Deaths and other Casualties.		Seamen discharged on paying off Ships.	
	Seamen of all classes.	Pure Blue Jackets.	Seamen of all classes.	Pure Blue Jackets.	Seamen of all classes.	Pure Blue Jackets.
In 1861-62.....	2,982	2,864	6,865	5,097	7,017	5,221
In 1862-63.....	3,094	2,980	5,089	3,560	7,554	5,286
In 1863-64.....	2,635	2,517	4,385	3,166	4,415	3,188
In 1864-65.....	2,040	1,899	3,831	2,124	5,777	3,204
In 1865-66.....	1,496	1,470	3,815	2,007	4,419	2,362
Totals	12,247	11,730	23,985	15,954	29,182	19,261

NOTE.—In the above Table officers are excluded. In 1865–66 the average number of pure blue jackets borne was 21,097, the "waste" upon which number (2,007), it will, therefore, be observed, was *under* 10 per cent. If the men paid off (2,362) be added, the loss would be obviously more than 20 per cent. In the same year the "waste" upon 7,007 boys borne was 430, or about 7 per cent. only.

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	War of French Revolution, Feb., 1793, to March, 1802.	1793
		1794
		1795
		1796
		1797
		1798
		1799
		1800 for 2 l
		for 11
		1801 for 3
		for 10
		for 5 l
		1802 for 1
		for 7 l
	With France, April, 1803, to June, 1815. With America, June, 1812, to Dec., 1814.	in
		1803 for 11
		in
		for 7 l
		1804
		1805
		1806
		1807
		in
		1808
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		1812
		1813
		for 7 l
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		1824

land and Scotland only.

* NOTE.—

† These Numbers

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Ryder.] APPENDIX B. TABLE I.

Bonâ fide Seamen in the Navy (afloat), showing the Monthly Decrease and Increase.

Dates.	Continuous Service.			Non-Continuous Service.		
	Number.	Decrease.	Increase.	Number.	Decrease.	Increase.
March	19,939	..	..	3,868	..	
April	19,881	− 58	..	4,070	..	+ 203
May	19,914	..	+ 33	4,036	− 34	
June	19,744	−170	..	4,199	..	+ 163
July	19,843	..	+ 99	3,680	−519	
August	19,606	−237	..	3,829	..	+ 149
September	19,502	−104	..	3,648	−181	
October	19,479	− 23	..	3,501	−147	
November	19,330	−149	..	3,447	− 54	
December	19,071	−259	..	3,524	..	+ 77
January	19,297	..	+ 226	3,314	−210	
February	19,223	− 74	..	3,348	..	+ 34
March	18,920	−303	..	3,250	− 98	
April	19,106	..	+ 186	3,252	..	+ 2
May	18,937	−169	..	3,220	− 30	
June	18,923	− 14	..	3,247	..	+ 27
July	18,767	−156	..	3,084	−163	
August	18,762	− 5	..	3,115	..	+ 31
September	18,610	−152	..	3,107	− 8	
October	18,375	−235	..	2,999	−108	
November	18,270	−105	..	3,019	..	+ 20
December	18,240	− 30	..	3,128	..	+ 109
January	18,197	− 43	..	2,947	−181	
February	18,327	..	+ 130	2,950	..	+ 3
March	18,320	− 7	..	2,881	− 69	
April	18,238	− 82	..	2,843	− 38	
May	18,379	..	+ 141	2,833	− 10	
June	18,266	−113	..	2,730	−103	
July	18,158	−108	..	2,678	− 52	
August	18,146	− 12	..	2,654	− 22	
September	18,158	..	+ 12	2,597	− 57	
October	18,105	− 53	..	2,559	− 38	
November						
Total		2,661	827		2,112	817
		827			817	
		1,834			1,295	

Diminution in the number of *bonâ fide* seamen in the Royal Navy in 32 months, viz., from March, 1864, to October, 1866 3,139

Notwithstanding all entries and re-entries of seamen, and the addition of about 4,000 young seamen rated from boys.

As every boy who is rated a seaman fills up a vacancy, we must add the number of boys so rated to the above diminution to obtain the waste of seamen during the interval 4,000

Waste of *bonâ fide* seamen in the 32 months 7,139

or 12·7 per cent. per annum on 21,000.

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[Admiral Ryder.] APPENDIX B. TABLE II.

The Annual Waste of bonâ fide *Seamen in the Royal Navy from all causes since* 1861.

YEARS.	Seamen, including Officers, Artificers, Domestics, &c.		*Bonâ fide* seamen afloat on 1st April in each year.	Uncompensated waste, notwithstanding the entries and re-entries of seamen from the shore, and the men rated from boys.	This Uncompensated Waste was as follows:				
	Voted.	Borne.			*Bonâ fide* seamen who left from all causes.	Entries and re-entries of *bonâ fide* seamen.	Waste of *bonâ fide* seamen.	Boys rated seamen.	Uncompensated waste, as given in col. 4.
	1.	2.	3.	4.	5.	6.	7.	8.	9.
1 April, 1861	Afloat 46,446	48,960	32,792	..	..	..	..	..	..
	Coast Guard on shore 4,000			4,107	10,318	− 3,347	= 6,971	− 2,864	= 4,107
1 April, 1862	Afloat 43,547	45,109	28,685	..	..	..	..	..	..
	Coast Guard on shore 3,850			3,286	8,846	− 2,580	= 6,266	− 2,980	= 3,283
1 April, 1863	Afloat 43,034	42,008	25,399	..	..	..	..	..	..
	Coast Guard on shore 4,500			1,431	6,354	− 2,406	= 3,948	− 2,517	= 1,431
1 April, 1864	Afloat 41,614	42,413	23,968	..	..	..	..	..	..
	Coast Guard on shore 4,000			1,593	5,328	− 1,836	= 3,492	− 1,899	= 1,593
1 April, 1865	Afloat 40,680	40,731	22,375	..	..	..	..	..	..
	Coast Guard on shore 4,000			1,278	4,369	− 1,621	= 2,748	− 1,470	= 1,278
1 April, 1866	Afloat 39,914	38,809	21,097	..	..	..	..	..	..
	Coast Guard on shore 4,200								
1 April, 1867	Afloat								
	Coast Guard on shore								
				11,695	35,215	11,790	23,425	11,730	11,695

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[Admiral Ryder.] APPENDIX B. TABLE III.

The Waste of bonâ fide *Seamen in each year shown in percentage of the number of* bonâ fide *Seamen on Ship's Books on the 1st April of each year.*

Years.	1. Loss from all causes.		2. First Entries and Re-entries.		3. The Waste, being the difference of the last two columns.		4. Boys rated Seamen.		5. The Uncompensated Waste being the difference of the last two columns.
1861–62	31·4	—	10·2	=	21·2	—	8·7	=	12·5
1862–63	30·8	—	9·	=	21·8	—	10·4	=	11·4
1863–64	25·	—	9·5	=	15·5	—	9·9	=	5·6
1864–65	22·2	—	7·6	=	14·6	—	7·9	=	6·7
1865–66	19·5	—	7·2	=	12·3	—	6·5	=	5·8

NOTE.—In estimating what the waste of *bonâ fide* seamen is likely to be three years hence, as a guide to the number of boys to be entered this year, we shall find that there are fourteen outlets.

I. *Casualty Waste.*

This is the only waste recognized as such by Mr. Reddie. It amounted to about 9·5 per cent. in 1865–66, and is believed to include:—

1. Invaliding.
2. Death.
3. Discharged to shore (previous to paying off).
4. Desertion.
5. Discharged with disgrace.
6. Discharged as objectionable.
7. Discharged by purchase.
8. Discharged on pension.
9. Discharged per order.
10. Discharged on request.
11. Discharged for incompetency.
12. To the shore on continuous-service engagement ceasing (previous to paying off).

II. *Paying off Waste.*

This takes place among the non-continuous service men, and amounted apparently to about 3 per cent. in 1865–66.

III. *Waste arising from men sent to Coast Guard ashore.*

Owing to the Coast Guard ashore having nearly reached their normal state as to age, we must anticipate that a much larger number of volunteers from the fleet will be required annually, viz., 1·8 per cent., instead of under 1 per cent.

Probable waste for the future in the *bonâ fide* Seamen serving afloat ..... = 9·5 + 3· + 1·8 = 14·3

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[Admiral Ryder.] APPENDIX B. TABLE IV.

Showing the Annual Supply of Boys each year to replace the Waste of Seamen.

Years.	Boys Voted.		Boys actually in the Service on 1st April, each year.		Boys entered in Training Ships each year.	Boys left Training Ships for Sea-going Ships, each year.	First Class Boys who were entered in H.M.S. "Excellent," and the Royal Navy generally, independent of the Training Ships.	Total Supply of Boys to Sea-going Ships, being the Sum of Cols. 6 and 7.	Probable future Supply of Young Seamen from Boys rated Men, allowing them two years as 1st Class Boys previous to being rated, and allowing a waste of 7 per cent. per annum after leaving the Training Ship.
	Afloat.	In Training Ships.	Afloat.	In Training Ships.					
	1.	2.	3.	4.	5.	6.	7.	8.	9.
1 April, 1861.	6,554	2,000	9,938 Boys for training ships not distinguished.				968		
1 April, 1862.	6,953	2,500	7,421	1,871	2,210	1,520	412	1,932	
1 April, 1863.	6,966	2,500	5,813	2,210	2,351	1,611	260	1,871	
1 April, 1864.	4,886	2,500	4,862	2,703	1,870	1,847	175	2,022	1,644
1 April, 1865.	4,320	3,000	4,483	2,242	2,116	1,596	86	1,681	1,618
1 April, 1866.	4,586	2,750	4,739	2,404	—	—	—	—	1,748
1 April, 1867.	—	—	—	—	—	—	—	—	1,447
1 April, 1868.	—	—	—	—					
Total..	..	..	..	..	8,647 For four years.	6,574		7,506	6,467

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[Admiral Ryder.] APPENDIX B. TABLE V.

Supply of Boys.

Average Number of Boys on Ship's Books each year.		Number of Boys entered each year.	Number of Boys Rated Men each year.	Remarks.
Year.	Number.			
1858–59	6,006	1,935	1,865	If we carefully study this Table, we shall ascertain that about 29 per cent. of every 100 boys that are entered in the training ships are wasted before they are rated men in sea-going ships. So that in order to rate 1,000 young seamen from boys in the course of the year, 1,408 boys must have been entered in some previous year; and as about 3,000 young seamen are required every year, 4,224 boys should be entered in training ships every year.
1859–60	8,388	5,244	1,643	
1860–61	9,418	3,607	1,747	
1861–62	9,523	3,246	2,864	
1862–63	8,519	2,647	2,980	
1863–64	7,479	2,673	2,517	
1864–65	6,880	1,790	1,899	
1865–66	6,888	2,279	1,470	
1866–67				
1867–68				

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LECTURE.

Friday, May 31, 1867.

LIEUT.-GENERAL SIR GEORGE ST. P. LAWRENCE, K.C.S.I., C.B., in the Chair.

THE COMMUNICATIONS, COMMERCIAL AND MILITARY, BETWEEN THE STEPPES OF CENTRAL ASIA AND HINDUSTAN.

By Colonel R. A. SHAFTO ADAIR, F.R.S., A.D.C. to the Queen.

The CHAIRMAN: I have the pleasure to introduce to you Colonel Shafto Adair, who has kindly consented to lecture on the routes, military and commercial, between British India and Central Asia, a subject which, although of the greatest importance to us, is but little understood in England.

Colonel ADAIR: It probably has very seldom happened that a subject which has been submitted for discussion in this theatre has occupied prominently, at the same time, the attention of the public; and when we are dealing with a matter which, as you, Sir, have well observed, is of the utmost importance in the imperial relations which connect India with this country, it is perhaps fortunate that it is so, for looking at the weight which the opinions of the members of this Institution carry with them, not only in this country, but throughout the civilized world, incorrect impressions might be produced of the favour or disfavour with which a particular policy is received by the public, if it had been the subject of deliberate discussion before the members of the Institution. Therefore, had I been at all aware—could I have supposed—that the subject of to-day's lecture would have so suddenly assumed the prominence to which it is entitled in the public press, and in the public mind, I should have deliberated whether I had not better request from the Council permission to withdraw or postpone this lecture, or to substitute some other subject. But standing here with the consciousness that I have not adopted a foregone conclusion, that I am not prepared to recommend any policy which will be affected by what is in the public press, I trust I shall not only myself be acquitted of any idea of improperly applying the weight that attaches to discussions from this desk, to the subject on which I shall address

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you, but that the Council also will not be supposed to express an opinion on points which are not already prepared for decision.

The public mind has indeed been deeply stirred on this subject, and it is somewhat remarkable that on the very same day that the letter from Calcutta which has given rise to so much comment was published in this country, the approbation of one of our highest scientific societies—the Royal Geographical—was given to an Officer who had been mainly concerned in scientific proceedings having reference to this very subject. I find that in the proceedings of the Royal Geographical Society, the "Founder's medal was conferred on Admiral Alexis "Boutakoff, of the Russian Imperial Navy, for being the first to "launch and navigate ships in the Sea of Aral, an achievement which "led to the establishment of steam navigation on that sea, and up the "great river Jaxartes, into the heart of Turkestan; also for his subse-"quent successful survey of the chief mouths of the Oxus, in the "Khanat of Khiva. In having proved that the Jaxartes of the "ancients (the Syr-Daria of the Asiatics), which flows into the "northern end of the Sea of Aral, is a stream which steam vessels "can navigate for upwards of 500 miles above its mouth, a safe line "of communication between Europe and China, through Western "Turkestan, was first laid open to Europe. While Britain, therefore, "holds her own high road to India and China by the ocean, Russia, "after trading overland for centuries with Western China under great "difficulties, owing to the intervention of barbarous and hostile tribes, "has opened out for herself a course along which, by the interposition "of small protective forts, she will have a safe trade through Turkestan "with the Celestial Empire."

So much relates to the services rendered to science by this distinguished Naval Officer; and you will agree that the recognition has been well deserved.

With regard to the inferences that are to be drawn therefrom, my impression is, that it will not be difficult to find reasons for supposing that that extension of geographical science which has been viewed with apprehension, will, in the end, tend not only to the advantage of the countries conterminous with the Syr-Daria, but also to that of Asia at large, and of the two great empires by whose fiat the destinies of Asia, humanly speaking, must be regulated.

Yet there are other impressions abroad in India amongst our fellow subjects, in the localities where they are best able to form an opinion of the results likely to be obtained by that development of Russian scientific power. It appears from the *Calcutta Gazette*, in a letter of the 27th April, that general alarm and uneasiness extend through India with regard to these advances of which I am speaking, that astonishment is expressed at the inactivity of our policy, which those on the spot are perfectly capable of estimating, and of expressing an opinion upon. But this also appears, which gives better hope for the future of our Indian Government than almost any one fact—that whatever is matter of importance in the arrangement of our policy, is now the free subject of discussion amongst the natives and through the press. Officers who have been in India know well how difficult it

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was to ascertain the truth of Bazaar reports. They know how impossible it was to penetrate the secrets of the native Courts, and the intrigues of native diplomacy. Give India a free expression through her press of what her people think, and the rumours of the Bazaar will be converted into truths, and the secrets of diplomacy will no longer exist to entangle us in our relations with the native Governments.

I estimate, then, as of great importance these remarks coming from India. I will not at this point enter upon the policy that I should be prepared to say might result in accordance with the suggestions, but I will merely call your attention to the fact that these reports are in existence; that the public mind of India is disquieted; and that, in sober judgment. Without sacrificing one atom of the honour of England, without sacrificing one shred of the power and prestige with which we are bound to invest our Indian Government, means of adoption to the new system which must prevail in Asia will be found, and England will have no reason to repent the change, or the policy which she may be induced to adopt in accordance therewith.

But now to commence with the subject, from which I should not have made this diversion but for the accident of public notice: "The "Communications, Commercial and Military, of the Steppes of Central "Asia with India."

My attention was directed to this subject as long ago as last year. Her Majesty's Indian Department had prepared a most elaborate system, showing the caravan routes as they have existed for some time, the principal marts of commerce, the points at which trade and commerce may be diverted from, or flow into India, and, as I assume, with the purpose of considering some enlarged system of commercial expansion such as has not hitherto been originated or worked into one continuous plan. It occurred to me that possibly having so much of foundation and accurate knowledge from which the basis of an argument could be derived, that it might not be without advantage, especially when we have so many Indian Officers competent to correct with their enlightened criticism mistakes and erroneous statements, to bring this matter prominently before the Institution. The Council assented to my wishes, and the next step was to obtain permission to have a copy made of the Government map. I applied to the Secretary of the Indian Museum, Dr. Watson—I hoped we might have been favoured with his presence on this occasion—and he, with the utmost liberality, placed all the materials at my disposal.

I have also reason to believe—I imagine it will come within the knowledge of many Indian Officers—that there are many unexplored, or if not altogether unexplored, unnoted passes to the northward and north-west of India, through which Officers in their excursions on leave have penetrated, of which they have preserved such records and accurate statistical details as will be exceedingly valuable on a future occasion. Circumstances have prevented me from availing myself of the very obliging permission of the Indian Department of access to those documents. I appreciate the liberality of the offer, and rejoice to think that a magazine of such information is within reach.

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Now, I spoke of the two great empires on whose influence the destinies of Asia will rest; and for the purpose of to-day's argument, I mean the Asia that lies eastward of the Persian frontier and of the Ural Mountains. Properly speaking, Siberia can hardly be included in Asia as regards Asiatic characteristics, for it is a country under European Government, and not only under European Government, but under the predominant influence of European laws, habits, and religious observances. Still I shall have to deal with the southern frontier of Siberia, and so far include it in the great Asiatic system.

There are four great masses of power in Asia. Now, the "balance of power," as it has been called, has occupied the attention of diplomatists from the time when a regulated system of diplomatic intercourse arose on the ruins of the feudalities of the Middle Ages. The maintenance of this dogma has probably caused more wars than even dynastic ambition or the baseness of favourites. It is proverbially difficult of handling where the matter in dispute is of small moment, and amongst States occupying comparatively small spaces, and where an habitual equipoise is more or less well assured; but to maintain the "balance of power" becomes of an enormous and excessive importance when it is between nationalities, faiths, nations, occupying portions of a large continent. The four great influences are: the Russian; the Chinese, with the vast dependent tribes of Mongolia, the Khalkas, the Kalmucks—the affiliated Chinese, as they may be styled, who profess a variety of the same Buddhism; England is the third; and the great mass of Mahomedan and Kaffir tribes and nations, in the Asiatic sense, forms the fourth. The question on which we are speaking this day will affect, to a great extent, the future position of that fourth division of Asiatic society, as independent communities.

And, first, with regard to the mode in which the influence of that great people who form the Empire of Russia has been obtained. Surely "they are a wise and an understanding people," who, for generation after generation, without pause, without hesitation, without relaxing a distinct and decided mode of action in the slightest degree, have persevered year by year in the Russian policy, a policy, whatever the estimate that may be formed of it in Europe, that has benefited largely the vast regions of Siberia over which it has extended. It is barely 300 years since Russia, itself an aggregation of conquered kingdoms, found a bold adventurer who dared to look eastward from the slopes of the Ural, and to discover for himself what manner of tribes and regions lay beyond those mighty mountains and those misty steppes which are now within the second line of the Russian frontier. Yermak, the Cossack, in 1580, gained as truly a new empire to Russia as Columbus to Spain. Then began the Russian system with well developed thought, careful intelligence, moving on day by day, first eastward, then southward, employing all the marvellous machinery that accident and nature have placed at the disposal of the Czar to consolidate its resources, till at length the power which in 1580 knew not where to plant a sentry beyond the Ural, in 1867 has its advanced post at Djuzzak, within a few leagues of the capital of Timoor.

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It is striking to observe, on the Russian territory, the second frontier, or rather an original frontier of civilization within the second, or southernmost line; and this frontier is studded in its length, far away into the eastward, by forts which became cities, and by cities which have become centres of commerce. Passing from Orenburg to Orsk, and on the alternative or northern line from Perm to Ekaterineburg, Omsk, Tomsk, Tobolsk, Krasnoiarsk, thence eastward to Irkoutsk, are found the marks of that deliberate progress which, being based upon commerce, has, like all operations that result from scientific and beneficent principles, produced its marvellous result in the increase of the Russian Empire. But after a time it would seem that the mineral wealth of the Siberian territory attracted their attention, and the frontier was pushed southward to the centre of engineering operations at Barnaoul, and to its southern dependencies of Semipolatinsk and the mining stations. Barnaoul, it would seem, is destined to be one of the great centres of power in Siberia, and so far will Russia consolidate the purely European system of administration.

Now, the history of her advance is very remarkable. Russia possesses the services of a race eminently warriors and eminently merchants—the Cossacks. The Cossack can fight and he can bargain; he can abide and he can endure, and he can advance; he can assimilate with the tribes with which he comes in contact, and he has a hardihood and fidelity which leaves nothing to be desired in the character of a colonizing soldier. Judge from the remarkable history of the foundation of a city, destined to be very important—the city of Kopal—in 1846 or 1848. The most instructive writer that has described Siberia and the Amoor, Mr. Atkinson, tells us that he found a Captain of Russian artillery of the name of Abakamoff in a gorge near the Ala-tau range. He had marched for 40 days through rough country with six guns and a hundred men. He had established himself in log huts with his soldiers for the winter, to await the spring, which would bring down with it the usual implements of Russian power, and lead to the foundation of a new colony. And thus Russia is served. On the remotest points of her frontier, an intelligence is visible which beats directly in unison with that of St. Petersburg. Wherever her rule passes her rule is uniform; and on the waters of the Baikal, that inland sea, the regulations of the Russian Navy are doubtless as faithfully observed as in the summer cruizes in the Baltic. This brings the frontier to the lowest point southerly to which it had reached previously to the later campaigns in Turkestan.

Thence moving onward in accordance with the circumstances of the times, and I am not here to criticise the Russian policy, the Russian columns pass up the Syr-Daria, occupy Tashkend, Khodjend, Kokhan, and finally halt at Djuzzak. I do not refer to the suggestions of the press, which do not belong to the dignity of a discussion on the acts of a friendly nation. Those considerations may be dealt with by the public. But, in fact, the Russian is now firmly established, and along the whole of the Siberian frontier there is no single point in front of, or athwart which, the communications, military and commercial, that have direct or indirect relation to India, must not pass, and be observed.

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We now come to the great basin lying between the ranges of the Indian hills and the plains of China. It is inhabited by a race that preserve, as we have seen in our last war, the military characteristics of the hardiest who, under Jenghis Khan and Timoor, swept Europe well nigh from east to west, and under Baber founded a mighty empire. With regard to the commerce of Asia, this great basin may be called the basin of production. It is confined at its outlet within a narrow gorge by the projecting salient of Russian territory south of Kopal, and the northern salient of Hindustan, where the Hindoo-Koosh rears its crests, and the Himalayas have passes into the Indian Peninsula. Therefore, the communications, considered in their strictest and direct sense, are reduced within a very small and narrow earth-surface. Passing westwards they converge at the centre of Asiatic commerce at Bokhara. With regard to India, currents of traffic are diverted from the main stream of commerce which flows with even flux and reflux eastward and westward, and diverges through Tibet, by Khoten, Leh, and Lassa, and the passes that lead down through the Cashmerian territory into the plains of India. Sweeping round the north-western promontory of the Hindoo-Koosh, they proceed to Herat and Cabul, and may ultimately be determined in no inconsiderable degree to Kurrachee, and thence to the Western Coast of the Indian Peninsula. There are subsidiary streams. There is the commerce that seems to flow backwards, as we might almost say, or westward and eastward, through the passes of the Nepaul hills, and converges at Calcutta. Again, there is a point not so directly connected with the trade of Central Asia as those previously indicated—but which no survey of Indian commerce could be complete without considering—the depôt at which the resources may eventually be drawn and concentrated from the south-western provinces of China, terminating by communications on the sea at Moulmein. It may be recollected that some years since a distinguished Officer of the Royal Navy proposed to establish a communication with the south-western provinces of China, and especially with Yun-nan. This plan has been submitted to Chambers of Commerce in this country on several occasions. The Indian Government, it is believed, has pronounced against the scheme, but the Chambers of Commerce are of opinion that such a route is practicable. Looking at the proposed route with such information as is at present attainable, it appears that, with certain developments of railway or water transit, it is not unreasonable to suppose that the expected traffic might be developed, and for this reason: it would pass, it is true, through a barren country, but to open out a connection between the abounding Burmese territory and the swarming plains of South-Western China is of such fair promise that loss on the special cost of transit might judiciously be encountered.

The last portion to be considered is, that Turkestan, Afghanistan, the Khanats, and the still unconquered, or at all events insubordinated, regions of the Kirghis, are all concerned in the Indian traffic. And taking Bokhara as the central point from which commerce is to radiate, it appears to me that too much attention cannot be paid on our part to

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the interest that India has in the connection with these countries, both in a commercial and from a military point of view.

Bokhara has been defined to be the commercial centre of Asia. The points of ultimate destination are Nijni Novgorod, in the line of St. Petersburgh; of Trebizond, important in the Middle Ages, but of which the importance has very much diminished; of Bombay, drawing its communications from Kurrachee; of Calcutta, drawing, to a certain extent, the resources of the basins of Thibet; of Moulmein, which eventually will, it is to be hoped, be placed in direct relation with South-Western China by land; and of Pekin, which has a special and peculiar influence on the commerce of Eastern Siberia and Mongolia.

I attach much importance to the consolidation of our means of transport on commercial routes, because where the merchant travels, the soldier marches; where the merchant brings his wares, the soldier finds his stores; where the native feels the confidence that draws his produce to the bazaar, the soldier gets the daily supplies which are necessary to his support, the General forms his magazines, and thence, a basis of operations.

Now, with regard to the points of destination, Bokhara has settled communications with Khiva; and Tashkend, which has now passed under the Russian sovereignty, with Samarkand, with Cashgar, and with Yarkand especially as a depôt for the Eastern Siberian, and Cis-Himalayan commerce, and for a large proportion of the Chinese trade. To Pekin there are two routes over which communication is made with Eastern and Central Siberia. These routes must be of high antiquity as forming the means of communication with Eastern and Central Siberia before the country had become generally arranged and policised under Russian rule. There is additional reason for this opinion, since on the most easterly, lies the city which is recognized as the chief residence of the Lama of the Northern Buddhists; and I make particular remark upon this point, because I desire before I conclude to advert to a subject which has not yet generally attracted notice, and yet materially concerns civilization, Russian or English.

With regard to the destination of commerce, Bombay, Herat, and Cabul, are intermediate depôts of concentration and diffusion. Many speculations have been formed as to the possibility of establishing or perpetuating fairs and markets on that line, and we know from the records of that noble public servant who perished in Cabul by the assassin's hand, how largely he derived information from the inhabitants of remote districts who frequented those fairs.

There remains to consider the base of Thibet and its dependencies. It is satisfactory to observe that an agent has recently been appointed to Leh; it may be assumed, therefore, that it is the purpose of the Indian Government to increase, if possible, its activity of inspection on a frontier whose policy concerns India so nearly.

It has been asked in the public press, "such and such being the "state of affairs in Central Asia, what is to be done?" We are told at home that a policy of expectation, such as has been well

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described as a "masterly inactivity," is in favour, and I by no means object to adopting every possible precaution before entering upon a system of policy, in order that when we lay our hands to the plough we may not turn back. On the other hand, our fellow-subjects in India are disquieted, and will require a definite and active policy.

Well, there is the choice of either of two policies. There is the policy of caution as distinguished from distrust; as there is the policy of open demonstration on grounds sufficient to warrant distrust. There is also the fatal policy of placing trust in all representations that are made, forgetting this, that the march of empires is like the sweep of the avalanche; that a nation once committed to a policy, can very seldom recede from it, whatever the desire of the rulers may be; and that, therefore, it is a wise and a justifiable, nay, a necessary, attribute of statesmanship, while you respect, and adopt in their fulness, expressions of amity and peace, to beware lest events be stronger than the speaker, and lest lack of precaution may prove your policy seriously compromised and imperilled at some unforeseen conjuncture, when you would be justified in preparing against untoward fortune, though confidence in Governments, as in individuals, remain unimpaired. The policy of distrust, which leads to overt demonstration, is obvious enough. It is exceedingly easy to push forward outposts, to mass troops, to prepare magazines, and thus undertake the burden, as we have seen unhappily in Europe, of heavy armaments, increasing in direct proportion at each successive stage, until at last, as occurs in all such matters, a conflagration comes from some unexpected quarter. If masses of aggressive force are collected, those masses will assuredly not be resolved into their primitive elements and disintegrated, without serious convulsion and shock. There is no conductor that will draw off the animosity of banded nations.

Again, may it never be British policy to endeavour to interpose obstacles in the march of a nation whose labours are for civilization. It is an advantage to civilization that the barbarous powers should feel the restraining hand of civil, military, and judicial guidance. It was on behalf of civilization, that that great effort has been made, which has left, alas! so many French soldiers on the slopes of the Atlas. It was on behalf of civilization, that Russian power has left many of her soldiers on unnoted fields. It is well for civilization that England has always been prodigal of her sons wherever civilization should be extended, whether it was in the wild hills of Asia, or on the rarely visited shores and lagoons of Eastern Africa. Nor is it consistent with judicious forecast to narrow the field, if there be a field of contest on which an antagonist is to be met, with prudent development of power; be sure that on a great scale of operations, and on a long trial of years, the Government that deserves best, by preparation and foresight, will remain master of the field. Therefore, I do not sympathise with the apprehension so widely expressed in weighing the strength of the great empire to which so much reference has been made. I am prepared to believe that that power will be administered wisely and well.

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It is certainly the result of a long-conceived and well-balanced system of policy. However we owe a duty to our own possessions to remove disquiet, that men should know that, as a great statesman once said, "where the British flag has floated, foreign dominion shall not "come."

What is the policy I would recommend? Britain is different from other Colonizing States in this, that she unites in her mode of acquiring territory, both the qualities that are necessary for colonization, as against the aboriginal inhabitant, or as against the brute force of unreclaimed nature; and those varied gifts which enable her to reconcile to her rule the dwellers in old constituted monarchies, monarchies which had a place in history, and a glorious place too, before the Roman had visited British shores. She waits for the operations of trade to win influence, while prepared to vindicate the free exercise of that trade by arms. The type of British civilization is the factory; the type of British occupation is the solitary fortress resting on the sea, the base of operations of English war. From what root has the great tree of British power in India sprung? From the root that it struck deep in the soil in Bengal and in Madras, when, as yet they were few, and merchants, and only known as men who were permitted not by any favour won in abject and slavish humility, but who, through force of character, won freedom of commerce with the native states; whence in the fulness of time, and through the exercise of a just policy, and one in subordination to the purposes of civilization, their successors became the prince rulers of wide India. As the policy has been, so the policy should be. It does not appear that we can argue any legitimate distrust of our intentions, if the Indian Government developes our system of trade with a larger and more wide success beyond our Indian frontier, than has yet been attempted.

Some remarks of the accurate traveller and observer, now lost to his country, whom I have before quoted, in which he speaks of the policy as well as of the facility for extending English commerce, are noteworthy.

"In 1849, a considerable quantity of English calicoes reached "Yarkand, Kokhan, and Tashkend. They were printed in the two "latter towns, in patterns to suit the taste of the people; from their "superior quality and price, the Tatar merchants were induced to pur- "chase the goods and carry them in their trading expeditions among the "nomades of Central Asia. They also found a ready sale, and the "people were delighted with their new garments. Several of these "Kalats were shown to me, and their superior quality commented on "by their owners. All were anxious to possess them, thus the articles "had at once established a character and a trade.

"The following year, when the merchants visited Kokhan and "Tashkend, they obtained similar goods, and these were still more "appreciated by the Kirghis. In 1851, the Tatar traders bought their "goods as usual, which in appearance resembled those of the former "years. These were taken by the caravans into distant regions, and "they also met with a ready sale. But, alas! the purchaser soon dis-

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"covered that he had been victimised, the material proved to be com-
"plete trash, and the discovery caused a great reaction. It was a
"fact well known in Siberia, that agents for English houses were in
"Kokhan, and from all I could learn, they were natives of India.
"This was not only a disreputable transaction, but a most foolish
"experiment, which has done considerable injury to trade among these
"tribes."* I quote this as a proof of the facility with which our commerce might be extended to Asia, and I quote it as a warning to those who dare to abuse the civilization which is now going on. He says also with regard to the Indian Trade (p. 354):—"English merchandise
"will sooner or later find its way into the northern provinces of China,
"through the Tatar merchants engaged in trade among the Kirghis
"hordes. I shall, however, point out another and more direct route
"by which commerce may be carried into these regions, if a fair were
"established on the Indus. During my wanderings I became ac-
"quainted with several merchants who had frequently visited Yar-
"kand, Kashgar, and Cashmere. Between these places caravans often
"pass, so that various wares are constantly being transported through
"this country without any extraordinary difficulty. It may, I think,
"be taken for granted, that wherever trade can be carried on with
"profit, all natural obstacles have been surmounted. It is a well-
"known fact that the caravans that travel from Kulja into some of
"the interior provinces of China, encounter greater dangers than will
"be met with between Yarkand, Kashgar, and the Indus." I refer to the elaborate map from which the one now exhibited is formed. The accuracy is remarkable, so far as I have had the opportunity of verification. On referring to this map, it will be perceived that, taking as before Bokhara as the centre of commerce, even with the diversion of route to Herat and Cabul, Kurrachee is within nearer range of Bokhara than the Great Russian Fair at present maintained at Nijni Novgorod.

Now my idea is this: Let the Indian Government determine at what spots an effort shall be made to develop Indian traffic. There will arise at each town a centre, not only of commerce, but of political action, and of confidence in British power, which will surround our frontier with, as it were, forts of peace, whence our influence will radiate with certainty, and, I believe, with successful results. I do not speak of the political advantage of obtaining information of a trustworthy character, I put that aside from the great question that affects the commerce of India, and affecting also her military communications, and I say that, as from the factory sprung the Indian Empire, so by the factory it may be extended and perpetuated.

Well, then, with regard to the *ratio ultima*—military operations. For myself, I have no doubt on the subject, if only—and this is a matter that weighs daily more and more on all men's minds—it be remembered that the India that we hold must be maintained by material force, not because our subjects distrust us, but there are those abroad who will overrun and plunder and overrule those subjects if we do not

* Atkinson, Upper and Lower Amoor, p. 290.

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help them. I do not feel the active distrust of that centre of native rule, under many rulers, that lies in the very heart of our territory, to the extent that many do; but it is clear that there must be amongst the native courts, men discontented and ambitious, who rapidly profit by any occasion of disturbance and public disquiet. I appeal to any Indian Officer whether, under special circumstances, a successful and distinguished soldier could not plant his spear and raise thousands of horsemen round his standard in the present day? You recollect that signal example of Sir Charles Napier. When the Chiefs of Trukkee surrendered to his chivalrous character, the news of their capture and submission spread throughout Asia. Men summoned towns in the name of Sir Charles Napier, to surrender, and the towns were surrendered; and Sir William Napier tells us, at that time it was perfectly possible, and I believe it, for his brother to have marched to the shores of the Mediterranean with thousands of horsemen, as the old chiefs did in the times of early history. The elements of uncertainty still float in the political atmosphere of India. The forces of administration of Government must be so consolidated that they who would aspire to combine those elements into agencies of offence will know that they will dash themselves to pieces against the granite strength of Government, for otherwise, all that has been wrought will be wasted. And again, when we have put the hand to the plough, we have no right to turn back. It was not to turn back from great achievements that this small island sent forth her sons to sweep through vast portions of the earth, reclaiming and benefiting the nations as they go. England has no right to practise, or to look forward to an inglorious ease, and to say, "What of this? and what of that? Let us part with this territory or with that possession." Part with any territory where the inhabitants have shewn that they are capable of self-government. Let them go forth into the struggle of nations, blessing and blessed. But where those subjects require, in the weakness of their stinted knowledge, direction and guidance, they must not be abandoned; and the Government in India which neglects to exercise material force, will commit a fault which is the greatest that an English statesman can commit. Apart from the lowering of England in the scale of nations—for what would be thought of England without India—the trust and the talent which is deposited in our hands will have been despised. That is matter for consideration with regard to military defence. I desire to see the maintenance of a well-defined policy beyond the frontier. We shall always be close enough to the frontier if the time of action arises, being prepared as those who wait constantly and watchfully.

There was one further point which has attracted my notice, and which may possibly not be unworthy of consideration. It is remarked in the public press, that Asia beyond India and Russia, is waiting for a Master. It is true! The old qualities of warlike aptitude and readiness for strife have by no means died out either in that great valley, or in the Mahometan and Buddhist kingdoms. There are probably Officers present who were in the last Chinese campaign. Do they remember what manner of men those were that came down from the

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northern plains, those Mongolians who fought so well; and who are the descendants, man and boy, of the men who marched westward with Jenghis Khan? Read the accounts of the still unreclaimed Kalkas, their aptitude for war—men that require nothing but grass for their horses—for themselves they will provide. Did you not see, in 1815, what soldiers Russia brought from her extreme east, the Bashkirs, who had marched from a province under the Great Wall to camp under the walls of Paris? Do you not know that there is a fanaticism of an exaggerated type still at work in Bokhara, which is aptly called the "Rome" of the neighbouring provinces? If Asia be left without a master—and by master I mean without the preponderating weight of humanising European influence, that master will be found. Some day the rumour will pass through the Steppes, some revival of a prophecy long forgotten, to tell the tribes that they are again to turn their faces to the westward—men bound to no soil but that where they can find forage for their horses. You would have—it is perfectly possible to imagine such a state of things—you would have a great mass and deluge of barbarian war poured through that narrow gorge between the Indian hills and the Russian frontier; and what race of mountaineers would you find in those hills? Officer after officer, who have employed their intervals of leave in hunting in the higher ranges, have told me, that there, especially at the head-waters of the Ganges and the Sutlej, and so over into Tibet, they have found races, of remarkably solid form and of European composition—men, Tatars ethnologically, but of great physical power, and of European habits to a great extent, who might be combined in an extended exodus of warlike emigration. And remember that the religious element would powerfully sway these tribes;—the whole mass of Buddhism, northern and eastern, of which the forces have not yet been calculated. But the Chinese Government knows them full well; for the Chinese Emperor subsidizes, and keeps in pay the religious chief whose seat is at Ourga, amongst the Mongolians, of whose warlike qualities we have so lately had proof.

It is essential that Asia should be quieted, and that European influences should dominate her regions. I have shown you how I think the English interest may be combined with a sound policy of justice to ourselves, and of fealty to the great member of the European commonwealth, whose frontiers are now approaching our own. But of this I am sure, that if Asia be left without a master, it will matter very little to India what the communications, commercial and military, between those Steppes and the Indian Peninsula may be, for though we may maintain, within our own bounds, the pre-eminence of civil rule, which we have done and suffered so much to secure, yet beyond, it will be one great sea of anarchy, over whose waters neither commerce will pass, nor truce nor peace abide.

The CHAIRMAN: Ladies and Gentlemen, I am sure you will cordially concur with me in expressing our warmest thanks for the able and highly lucid lecture we have heard from Colonel Adair. I, personally, have been at Cabool, and in some of the other countries which he has mentioned, and can express my entire concurrence in the views he has

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so lucidly laid before you. I have had much pleasure in acting as Chairman, though I took the place of certainly a much more efficient Chairman, General Eyre.

Colonel ADAIR: Sir George, I beg to return my best thanks to the meeting, for the kindness with which I have been received. And I may beg to say, that I take it as an especial piece of good fortune, not only to have had that expression of opinion from an Officer who has learnt in the hills what the warfare there is, and how to express an opinion thereon, but also as the brother of the great statesman who is now administering the Government of India.

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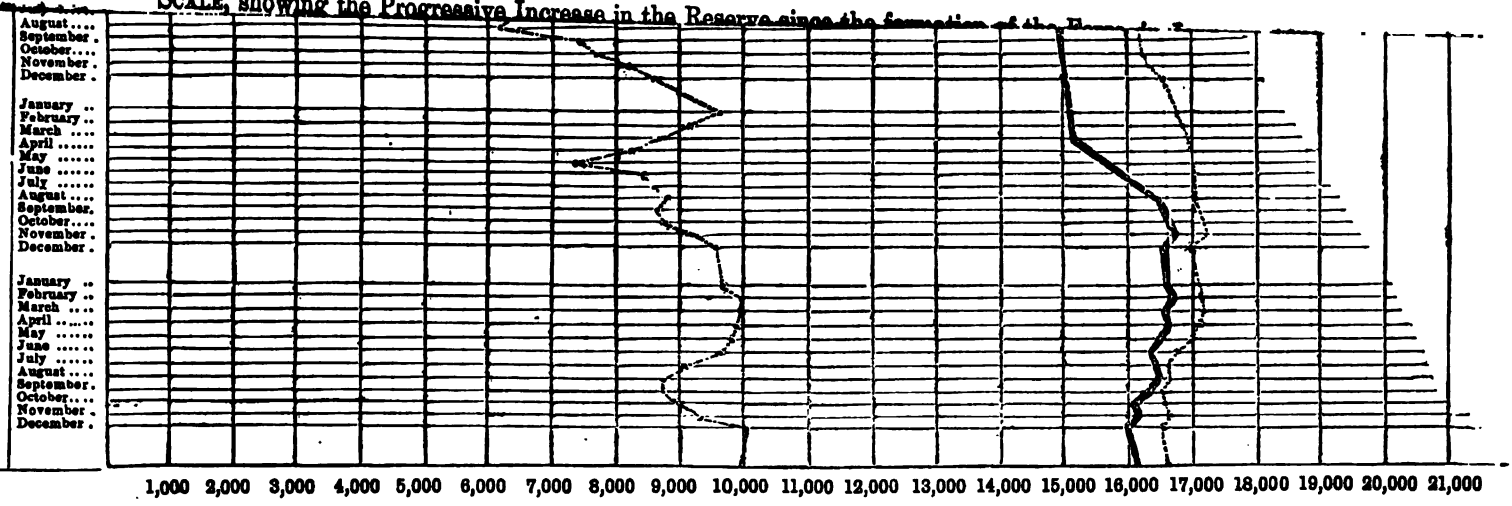
ROYAL NAVAL RESERVE.

[Diagram 1.

SCALE, showing the Progressive Increase in the Reserve since the formation of the Force.



NOTE.—12,000 Men had, on 31st Dec., 1866, completed the whole of their Drill in Great Gun, Rifle, and Cutlass for that year; and 4,157 were Absent with Leave on short voyages, and had not therefore completed the whole of their Drill, but will in all probability do so in the course of a few months.

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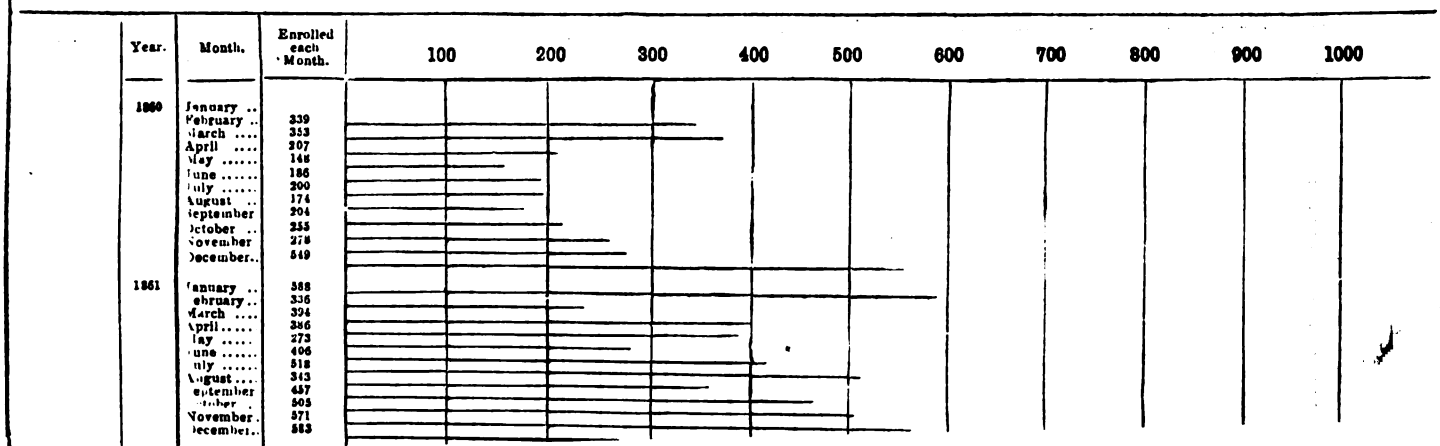
[Diagram 2.

ROYAL NAVAL RESERVE FORCE.

SCALE, showing the number of Men enrolled in the Force in each Month since the formation of the Royal Naval Reserve, in January, 1860.



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Evening Meeting.

Monday, June 10th, 1867.

COLONEL THE RIGHT HON. THE EARL OF LONGFORD, K.C.B., Under Secretary of State for War, in the Chair.

NAMES of MEMBERS who joined the Institution between the 10th and 17th June, 1867.

LIFE.

Western, Wm. T., Esq., Navy Agent. 9*l.*

ANNUAL.

Garnham, R. E. W., Captain 6th West York Militia. 1*l.*
Mackinnon, W. C., Captain 87th Royal Irish Fusiliers. 1*l.*

THE DRESS AND EQUIPMENT OF THE ARMY.

By Captain ARTHUR WALKER, Temp. h. p. (79th Highlanders).

I. *Introduction.*

In treating of the soldier's dress and personal equipment, I shall avoid as much as possible entering into the consideration of what may be termed æsthetic minutiæ, with regard to which there must always be great diversity of opinion, and shall simply endeavour to demonstrate that a considerable change in the present dress and accoutrements of the soldier has become desirable, and then attempt to point out generally the form these changes should assume. The important change as to the knapsack and ammunition pouches which has recently been proposed, and may still be said to be under consideration, will be referred to by me in the sequel; but I may here state that with the exception of this and one or two other slight and hardly appreciable alterations, the present dress and equipment of the army are, to all intents and purposes, the same as those which existed before the Crimean War, while the Enfield rifle was still a doubtful experiment, while breech-loaders were still regarded as practical impossibilities, and when, except to a few, the names of Armstrong and Whitworth were alike unknown.

But, since September, 1854, when the dream of European peace

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was rudely disturbed after a thirty years' slumber, what a prodigious experience has been our lot in everything connected with war and warfare! First came the Crimean War itself, then the great Indian Mutiny, followed closely by the Chinese War of 1860, and that of New Zealand in 1864 and 1865.

Then there was the Italian War of 1859, with its Garibaldian accompaniments; then the great American conflict between North and South, with the nearly simultaneous insurrection in Poland, followed closely by the war in Denmark; and last, though by no means least, the now famous and ever-memorable "Seven Weeks'" War of 1866.

What a martial category is this for twelve short years, and what tremendous results do these twelve years embrace! The map of Europe has been altered and retraced by the point of the sword; new kingdoms have been created, while old ones have been obliterated or so re-constructed that the geographer can scarcely recognize them.

Nor are the changes which these twelve years have wrought in almost everything relating to the art of war less striking and remarkable.

The sentry in the adjacent gateway carries in his hand a breech-loading rifle capable of killing at a distance of a thousand yards, and at the rate of something like ten shots per minute. Nor is his fellow-soldier in the Artillery a jot less advanced, possessing as he does a breech-loading field-gun qualified to deal death at an almost incredible distance, and with a certainty not less marvellous. But this is not all. Our whole system of field exercise has undergone, or is undergoing, a complete transformation since that memorable 20th September, 1854, when our battalions advanced "very slowly" across the plain of Burlick, and up the banks of the Alma River. At Aldershot these same troops may now be seen performing entire field movements at a pace which, unfortunately, as our men are at present clad and equipped, may well be called "killing." Lastly, rifle instruction, military gymnastics, and workshops with every facility for obtaining elementary education, form important additions to the soldier's occupation. To sum up, it appears that our arms, our ordnance, our drill, and many other things besides, have all undergone great reforms and radical changes; but the dress and equipment of the army form an exception—those remain all but unchanged, identical, in almost every particular, with what they were in the early days of the Crimean campaign. This is all the more remarkable from the fact, that every nation in Europe but ourselves has of late years more or less altered their clothing and system of accoutrements and packs, so as to make them harmonize as much as possible with the new conditions of warfare. There are no doubt many who regard this question of "army tailoring," as it has been somewhat sneeringly termed, as a very small affair; in fact, so secondary to the great question of army re-organization and recruitment, that it can well afford to wait until that problem has been finally solved. But although I perfectly admit the necessity of first catching your recruit before *dressing* him, I maintain, on the other hand, that the question under discussion is infinitely larger in its

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bearings than might at first be imagined; and that it involves *tactical* considerations of no small importance, inasmuch as it concerns the individual comfort and efficiency of each soldier in the army, and, as a consequence, his capability of endurance and mobility when on active service. At all events, my humble endeavour will be, in the following observations, to show that the subject of army dress and equipment is really one of very considerable importance, and one that cannot be overlooked in the consideration of any general plan for the reconstruction of the army.

I shall therefore proceed to discuss the different items of the soldier's uniform and accoutrements *seriatim*, commencing with his shako, and descending in detail to his boots; but before doing so, I will venture to make a remark somewhat personal to myself. During the six years I was attached to the Schools of Musketry, I had passing under my eyes every three or four months, fresh representative detachments from every branch of Her Majesty's forces. A quota was contributed in this respect from every Regiment of the Regular Army, Cavalry as well as Infantry, from the Militia, the Volunteers, the Navy, and Marines, from Colonial Corps, such as the Cape Mounted Rifles and West Indian Native Corps, and even from the Irish constabulary. It will, therefore, I think, be conceded that, beyond such opportunities of observation as I had in the Crimea, and in India during the Mutiny, I have thus had a particularly favourable opportunity of judging the practical working of almost every uniform in the British service. Moreover, acting on the principle that no one knows where the shoe pinches but the wearer, I seized every suitable occasion for eliciting the feeling and opinion of the officers and soldiers themselves with regard to this subject; and I may honestly say that what follows is not so much my own conception on these matters as the embodiment of the average opinion and feeling of the Army itself.

Having said this much by way of preamble, I will proceed with the details of my subject, as already proposed.

II. *The Head-dress.*

First, then, with regard to the head-dress. The present shako is doubtless a great improvement on that which our men threw away in such a wholesale fashion in the Crimea, but after all it is still a shako, and any praise must be of a negative nature; its appearance is incongruous and nondescript, although tolerably comfortable for home service—that is in a temperate climate—its deficient adaptability renders it a very indifferent protection for the head in what may be termed hot or cold climates. Now in our service, the suitability of the head-dress under the former condition should especially be provided for; and this remark applies indeed with equal force to every part of the English soldier's outfit, as nearly three-fourths of his service is passed in warm, if not in tropical climates; in addition to which, in cold climates campaigns are now, as a rule, only prosecuted during the summer months.

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The head-dress that would seem to be best suited for our service, and regarded by it with most favour, so far as I can make out, is a light and well-ventilated helmet-shaped hat, made either of cork or felt, as may be thought best, such, in fact, as is used in India so much by civilians and officers of irregular cavalry regiments, and which affords an excellent shade for the eyes and protection to the nape of the neck and head generally. A scarf or "pugree," of any texture or colour that may be preferred, wound round the base of the helmet, forms altogether an effective and effectual safeguard against the sun's rays, while in northern latitudes the same addition may subserve the purpose of promoting heat, the whole being at the same time light, cool, and becoming.

Helmets of the kind here referred to have been patented for many years by Messrs. Ellwood and Sons, under the name of "air chamber helmets," and are supplied by them in large numbers to officers of the Indian army. Here is a sketch of that, for example, supplied to the Bombay Staff Corps, together with a section exhibiting the plan of ventilation, &c.:—A. The inner crown to fit the head. Bbb. The air-chamber into which the air is admitted by apertures *ccc*. d. An aperture at upper part of outer crown to allow the air to pass out. eee. Tubes for ventilating the inner crown (*vide* Fig. 1).

These helmets are constructed in such a manner, that the rays of the sun falling on the outside of the helmet, are everywhere intercepted by a stratum of air (the best non-conductor of heat) and are thus prevented from passing to the head of the wearer, while at the same time internal ventilation is thoroughly provided for. Messrs. Ellwood assure me that the price of these helmets for the use of soldiers, would only be from about 7*s*. to 10*s*., and that they could make them so as to last for four or five years. The cost of the present shako, it is true, is only 4*s*. 7½*d*., but then it only lasts two years, so that, assuming Messrs. Ellwood's estimate of the durability of their helmets to be correct, this would make the actual cost about equal; but supposing that the adoption of these helmets should be the means of saving in India the life of even one man in a hundred—a very moderate estimate, which I understand can be abundantly verified*—and considering that every fresh soldier sent from Europe to India costs the nation £100, in a mere pecuniary point of view, and without any regard to humane considerations as to the increased comfort and better health of the soldier, there would be a great saving.

The weight of these helmets is about half a pound. They may be made sabre-proof, and of course any amount of ornamentation, in the

* Since these remarks were made, I have been informed that wicker helmet hats, with a cotton covering, have already been substituted for the shakos in India and the tropics generally. This salutary change was effected at the urgent representation of Lord Clyde after the Indian mutiny, on the experiences of which my observations were chiefly based. This only serves to strengthen my argument in regard to the want of adaptability in the shako, and as our soldiers have still to do duty in that head-dress in the all but tropical heat of a Mediterranean or Canadian summer, the sooner the above reform is extended the better. Even in England during the dog-days, a helmet hat of the kind in question would prove a god-send.—A.W.

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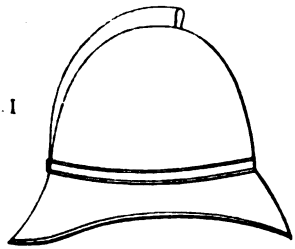
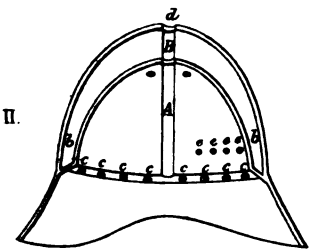
Fig. I



Bombay Staff Corps Helmet

Fig. II.



Section.

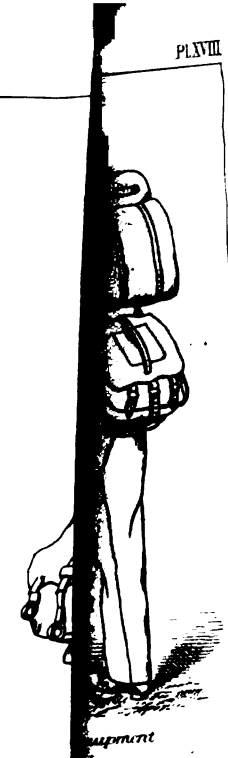


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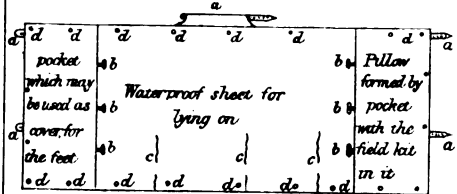
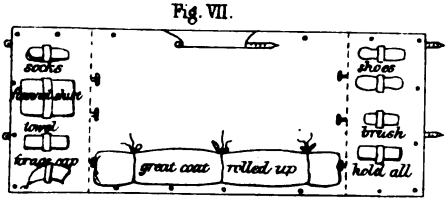
Fig. VI.


a
d d
pocket which may be used as cover for the feet
b
Waterproof sheet for lying on
c
Pillow formed by pocket with the field kit in it

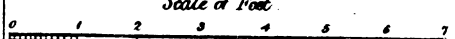
a, a, shows collar & fastenings available when the bed-haversack is being used as a waterproof cape.
b, b, toggles for fastening down the pockets.
c, c, fastenings for great-coat when rolled up.
d, d, eyelet holes.

Fig. VII.



Shows the bed-haversack packed with great-coat & kit ready to be rolled up.

Scale of Feet.



Captain A. Walker. Del.

The bed... for use.

The bed... fashion

Should it r... haversack (which can... may be fil... instead o...

...dress generally ...ker.

J. Jobbins

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shape of plumes, &c., may be added; but even without any such addition, such a helmet would surely become Britannia better than a shako. In Highland regiments, or at any rate such as wear the kilt, the Glengarry cap with black-cock feather and badge at the side, such as is worn by the London Scottish Volunteers, might be substituted.

To return to the shako, we understand that its colour is to be altered from blue to dark-green, and this is doubtless a change for the better, green being the colour complementary to red, and therefore the natural one to use in conjunction with a scarlet coat. The helmet hat may of course be made of this colour, nevertheless I give grey the preference, with bronze instead of brass for the ornamentation, for the very practical and sufficient reason that in sharp-shooting—even when in the lying down position, no part of the body is so much exposed as the head, and it is consequently most desirable to render the head-dress as little conspicuous as possible.

The present forage cap should make way for a soft cap, without any stiffening or tuft, shaped so as to fold flat in the kit, and at the same time be comfortable to sleep in when camping out; for this we cannot conceive a better pattern than that of the ordinary Glengarry cap, as worn by our Highland regiments, provided it is made of a better, *i.e.*, finer description of cloth. When properly worn and set on the head, nothing looks smarter or more soldier-like.

III. *Beard, Stock, and Collar.*

Adhering to the order of detail I have prescribed to myself, I am next met by what may be termed the stock and beard question; for, to a great extent, they hinge on each other. I may at once declare myself an advocate for the abolition of the one and the adoption of the other. At one time, indeed, many of us were under the impression that the dearly-bought experience of the Crimean campaign had settled this question; but, in truth, we military men are so disposed to hold fast and revert to our first love, that it would apparently require more than one Crimean war to wean our affections from that fond ideal of the "British Grenadier," bequeathed to us in connection with Brown Bess and the traditions of the past. But let us examine this matter dispassionately. Two objections are urged against the beard; the first is comprised in that epigrammatic remark of the late Sir George Brown, that, "where there is hair there is dirt, and where there is dirt there will be disease;" but the gallant old General failed to perceive that the same axiom rigorously applied, would involve the shaving of the head as well as the chin.

This favoured theory of the few, was indeed rudely dissipated in the Crimea, where the razor, the soap, the shaving brush, and looking-glass were soon thrown to the winds, and nature, in respect of the beard, allowed to take her course without let or hindrance; and I have been assured by medical men, then present, with great advantage, in a hygienic point of view. Catarrhs or colds, and sore throat showed a marvellous diminution, and many a man was saved "a galloping con-

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sumption" by being allowed to secure this natural protection for his throat and respiratory organs. How, indeed, could it be otherwise? Can any more effectual incentive to sore-throat, and all its train of evils, be imagined than scarifying the throat with a razor after lathering it with soap and water, so as to open every pore of the skin before turning out for two hours' sentry-work in a bitter north-east wind, on a winter's morning?

Besides constituting (in the opinion of the superior races of men) a personal adornment, the hair covering the mouth, and the beard over the respiratory organs, are wise contrivances of nature on behalf of man, who, as in the case of a soldier, is compelled by the very force of circumstances to be exposed to all sorts of weather. No doubt nature would have done the same for the woman of our latitudes if she had designed her for a similar and compulsory exposure.

The other argument against the use of the beard by soldiers is, that it would not be "uniform;" everybody could not cultivate a beard, even if they would; but the same may be said of the present regulation-whisker.

Judging, however, from appearances, it does not seem that more than a small percentage of our British race have any reason to complain of a short-coming in this respect; and I contend that, in the matter of mere military set-off, a body of men gains immensely by the use of the beard. Take a good Volunteer regiment, for instance, the Inns of Court, and will any one for a moment maintain that the adoption of the beard by them militates against their martial aspect? On the contrary, Mars has always been identified with a beard; and the association once established cannot easily be got rid of.

I well remember the effect produced on the 79th Highlanders, when they received the order for shaving off the beards with which they had returned to Canterbury from the Crimea. A tree with and without its foliage could scarcely present a stronger or more unfavourable contrast than that of these men with and without their beards.

In addition to this, I may observe that a great change has taken place in the feelings of the community at large, with respect to beards. One has merely to look at the benches of the House of Commons, the pulpits of the Church, at our railway officials, our mechanics, our artizans, and agricultural labourers; in fine, at the faces of the people we meet in the street, to be convinced that common sense has won the day, and that the beard movement has penetrated every class of society in the kingdom.

On what principle, then, can we any longer maintain this restriction as to soldiers, exposed as they are to such extremes of climate and inclemencies of weather? If we want recruits, depend upon it we should not begin by depriving them of this cheap, healthy, and becoming luxury, or rather, most desirable necessity of nature.

Beards or no beards, however—the strange inconsistency at present existing of allowing soldiers to wear the beard in India and during the voyage home, but depriving them of it the instant they return to the rigour of a winter in England or Canada, should surely be rectified. If the physiology of the matter be, as before explained, it is surely

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the unwisest course we could take, the immediate consequence of which is to send numbers forthwith to the hospital with colds, which may be destined to develop that consumption so fatal to our troops and the nation at large.

If beards were permitted, I apprehend that the leather stock would soon be discarded as a natural sequence. Strange though it may seem there are still Officers who have an affection for "a common soldier's stock," and justify its retention by simply saying that "they themselves never wear anything else," but in answer to this sort of *argumentum ad hominem* when advanced by a certain Brigadier in the Crimea, the *Times'* correspondent made the following pertinent remark, "*Ergo*, because he is riding at his ease on a fine soft-going "charger, with nothing on his shoulders, and being spare withal, feels "no annoyance from this singular anti-pneumonic apparatus, Private "Peter Brown, No. 1 Company, with 56lbs. on his back, 60 rounds of "ammunition, a close coat, a water canteen, &c., must positively like "to wear a similar article!"

If, as is asserted, stocks are essential in order to make the recruit carry his head in the approved military fashion, by all means let the recruit be drilled (but without his pack, &c.) until this is accomplished; but after the object is attained, why continue its use? it would surely be as unreasonable to continue the use of splints long after the broken limb has become thoroughly set and re-established.

But I am inclined to doubt altogether the necessity for thus *stocking* a recruit to make him keep his head up. No man can be made to take up any position habitually by mere restraint. If recruits are properly put through their extension motions and gymnastics, it will be found that the easiest and most natural position is the result, and this, after all, is the object of all training.

It is but fair to state that the stock has been considerably reduced in height recently; but is this enough? we think not, after what has been here adduced; if something is required for the sake of appearance, what is technically termed a "false-stock," consisting simply of a tag of black silk or thin leather, arranged so as to pass across the opening of the collar, would quite suffice. The majority of Officers to my knowledge now adopt this harmless device, which looks quite as well as the real thing, and causes none of its discomfort. Why should not this compromise then be allowed to the soldier, if the present stand-up collar of the tunic must inevitably be retained?

If however, stocks were finally abolished and beards sanctioned, it would I think soon be found expedient to have a neat-turned collar to the coat so as to leave the neck free, open and pliant, as it is with our own sailors and with the French Zouave, whose bronzed face, well trimmed beard, open collar, easy jacket, loose trouser, and well supported ankle, afford I think a far better beau ideal of a soldier's dress, than that we have managed to perpetuate. The turn-down collar suggested, could easily be so made as to stand up at will, dependent on the weather or the want of a beard.

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IV. *The Coat.*

I have thus glided into the consideration of the main item in the every day dress of the soldier, viz., his coat or tunic, as it is rather inappropriately called, inasmuch as the tunic was an under garment worn by both sexes in ancient Rome, reaching to or below the knees. Be that as it may, the present garb is generally allowed now to be faulty both in shape and material. The latter, for example, is too stiff and close grained, thereby rendering the garment cold in winter, and hot in summer, and in saying this much, I must not be thought to impute blame to the clothing department, who take I understand the greatest care that every yard of cloth issued should come up to the prescribed standard—it is the standard itself to which I take exception. The lighter and thinner the material, the better, provided it be sufficiently durable, and its texture such as to insure a certain degree of warmth in winter, and coolness in summer—conditions easily attained by adopting a pliant twilled flannel or tweed stuff, such as a man takes to in deer-stalking or grouse-shooting.

In order, however, to facilitate such a common-sense and salutary arrangement, the shape of the present garment must be materially modified. At present it is cut out and fitted too much on the vicious and obsolete principle, that "in a military dress a wrinkle is unpardonable, though a seam is admissible." It is still too tight over the shoulders, and across the chest, exactly where it should be most easy. The attempt to supplement the present tunic by a cardigan-waistcoat or woollen jersey, or, in short, to meet a decrease in temperature by a corresponding increase of under-clothing, is invariably attended by one of two results, either the bursting of the garment at its seams, or the objectionable sensation of feeling encased in a strait-jacket; so that, contrary to Dr. Johnson's well-known aphorism, that "a man must either be a fool or a beggar who feels cold in this climate," the soldier, although neither the one nor the other, has frequently to suffer from excessive cold, without the possibility of counteracting it. The recruit and young soldier for instance, are much exposed to cold during drill, with which great coats would greatly interfere, and, "in the opinion of the medical officers, his clothes are not sufficiently warm. It is therefore supposed that he catches cold more frequently than he otherwise would do, and that, in some cases, this brings on more serious diseases." These words are not mine, they are taken verbatim from the second report of the Committee on the present system of accoutrements and knapsacks.

The tunic is uncomfortable, too, in other respects. So long as a man has merely to stand up in it at "attention" on parade, it is all right, and looks pleasant enough, but its want of pliancy and its constraint become evident, when the soldier has to perform his position or running-drill, to act as a sharpshooter, or to use the spade in field-work. There is no ease or repose in the garment, and whenever men possibly can, they dispense with it altogether in favour of their great coats, and, at other times, of their shirt-sleeves.

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The want of proper pockets in the tunic and shell-jacket is much felt. Surely, of all men, a soldier should have pockets; not mere slits in the tail-end of his tunic, or the sides of his trousers, as at present, but good, roomy pockets, more like those a gamekeeper indulges in. I have often overheard serjeants complain bitterly of this want of pockets. They are expected to carry about with them a roll of their company, a memorandum-book, a pocket edition of the field exercise, and, during the musketry course, registers, pen, ink, &c. Now, at present, they have either to carry these in the tail-pockets of their tunics, or to unbutton the tunic at the breast, and stick in these various articles horizontally, so that, besides protruding in an unsightly manner, it often ends in more than one of them being lost during the day's duty. And if what I have said, as to want of proper ease and accommodation, holds true as to the tunic or "full dress," how much more does it do so when applied to the shell-jacket, which is expensive and tight—hot in summer and cold in winter—with no protection to the loins, where it is most needed, and, of course, devoid of anything in the shape of pockets; yet this is the garment in which we tell the soldier to take his ease with dignity—this is the dress in which we send him out to do a long day's field-work, to make roads or dig trenches.

The remedy for these drawbacks to the present tunic and shell-jacket is, to my mind, very simple and obvious; indeed the authorities themselves seem almost to have suggested it since the beginning of the year, by substituting, in the case of the Officers, for their former buttony, policeman-looking, undress frock-coat, a serviceable and sensible form of patrol-jacket, with good honest pockets and a due amount of adaptability as to an increase of underclothing, which I hold to be so essential in the dress of our soldiers.

Let this then, or something at least on this principle, become the pattern for the whole army, vice tunics and shell-jackets, and let there be but one pattern both for men and officers both as to cut and colour. The officer's patrol-jacket being a dark-blue, is objectionable on more than one ground. On service, for example, on an alarm, officers have been known to turn out, in the hurry of the moment, in their blue undress frock-coats, and with red coats on either side of them, have found themselves acting as so many centres or targets on which the enemy's sharpshooters plied their aim with deadly effect. Apart, too, from any consideration such as this suggests, the appearance of the contrast on parade is bad.

In addition to the ordinary badge of rank worn on the officer's collar, a belt and pouch, containing a field-glass,* might take the place with great advantage of the present crimson sash, and would serve to mark him out sufficiently, for all practical purposes, from the rank and file.

Abolishing the shell-jacket, and having only one pattern of coat, would be found to have an advantage, too, in an economical point

* The lecturer here exhibited a handsome Russian leather belt and pouch for a field-glass, designed at his suggestion by Messrs. Burrow, of Malvern.—ED.

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of view, for, after a patrol-jacket of the shape and material here contemplated had been worn a certain prescribed time, a new one would be served out for full dress, and the old one would become the soldier's undress. The recruit, on joining, being, on a similar principle, supplied with one new patrol jacket, and another, "partly worn," for undress.

I have spoken of the patrol-jacket as the tunic, so to speak, of the future, but I have done so more because I conceive it to be a step at least in the right direction, based on a good principle of ease, utility, and adaptability, and because Government have already to a limited extent sanctioned it as part of the regulation dress of the Army, than from any conviction on my part that this patrol-jacket is the perfection of a dress, and leaves nothing to be desired. Personally, I confess my feeling strongly inclines to a dress which has of late years been received with much favour by all classes of sportsmen, and known to them as "the Norfolk shooting-jacket." At present I cannot conceive a type of coat better adapted than this for the soldier; it is thoroughly workmanlike, and at the same time thoroughly presentable as to appearance. While sufficiently close-fitting at the waist and wrists, it has the advantage of being comparatively loose across the chest and shoulders and about the arms, while at the same time the skirt is just long enough to afford sufficient covering without at all being in the way. Moreover, owing to the arrangement of flat plaits down the chest, there is ample facility for any number of pockets being placed inside, which at least, in time of war, might serve instead of a haversack; and for that matter, in the case of a forced flank march or such like, instead of his knapsack. At the waist it is drawn in by a cloth belt or band, which can be let out to any extent, so as to give the jacket all the freedom of a blouse, when such is desirable.

In the one I have had made as a pattern, there are two roomy pockets, below the waistbelt, made strong and thoroughly waterproof, and each capable of carrying 10 or 20 rounds of ammunition. On each side of the chest are two pockets, accessible externally, although otherwise quite unobservable; the collar can be turned up or down at pleasure.

The jacket should, I think, be faced at each shoulder with soft red leather, so as to prevent its being soiled and worn by the rifle, as is the case at present. Moreover, this would serve as a slight pad for the butt of the rifle to bear against when at the "present," and so reduce the effect of recoil.

As to the colour of the cloth for our coat, there can be little doubt that for an army of riflemen—as ours now emphatically is—grey, or some good neutral tint, would in the abstract be the best. But, after much consideration, I am inclined to think that we must not attach too much importance to the supposed advantage of the so-called invisible colours for the uniform of at least the body of an army; in practice, at any considerable distance, the mass of intervening atmosphere sufficiently modifies and tones down even the brightest colour, and when we come to anything like close quarters, it really matters little what colour is worn. Indeed, the "flaming scarlet" has then a decided

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advantage, from its well known *scaring* effect when worn by the British soldier.

Moreover, Scarlet has been the national colour for many years, and has been worn in all our great victories, and is known as the British colour all over the world. There can be no doubt that for troops of the line its effect is brilliant and imposing. Practically therefore I believe red should be retained for the national uniform.

For my own part, I conceive that the Volunteer force would derive great advantage from assimilating the colour of their uniform with that of the regular army, and adopting the red universally. Firstly, its adoption (for it has already been adopted by a number of corps) is found to attract recruits; secondly, should occasion ever really arise for combining the regulars and Volunteers in the field, the enemy would not distinguish the one force from the other, and thus the two forces would mutually afford each other a sort of moral support; and thirdly, as has been already remarked, when worn by a mass of men, scarlet helps very much to cover (if need be) a multitude of sins as to the individual "get up."

At present unfortunately in the Line, the Officers and Serjeants only really wear scarlet, for the coat of the private is of a dull brick red, which might surely be improved without much additional expense.

Facings.

I will now say a word as to the "facings" of regiments before leaving this part of my subject, of which I have made, I fear, rather a long tale.

Different facings for different regiments are advocated on the ground of maintaining a regimental distinction and *esprit de corps*, and provided every battalion in the service could have a different coloured facing, I would not have a word to say against a system to which, I think, it is desirable to give the fullest possible effect; but unfortunately for this excellent theory as to facings, it can scarcely be said to have any real existence in fact, for on reference to the Queen's Regulations it will be found that of the 140 battalions of infantry (this does not include the four battalions of the 60th, with their green uniform and scarlet facings), 41 battalions have blue facings, 38 yellow, 21 green, 18 buff, 13 white, 4 black, 1 (the 56th) purple, and 1 (the 97th) sky-blue, so that in reality it appears only two corps, the 56th and 97th, possess what can be truly termed distinctive facings, for it can hardly be said that there is much distinction, or rather distinctiveness, in a facing which is worn by some 40 other regiments, as in the case of blue, and 38, as in the case of yellow. It is rather unfortunate too that blue and yellow facings should so largely preponderate, for, and in this I think the ladies will agree with me, of all colours, these two are least suited to be worn in combination with red; in common parlance, "they don't go well together."

It is obvious, indeed, that even if it were possible to give every battalion of the 140 a different shade of colour, in the majority of cases, harmony of colour and good taste would have to be sacrificed.

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In my opinion, therefore, it would be much better to rely on something else for creating a regimental distinctiveness.

Badges.

Let each regiment, for example, have a separate crest and motto assigned to it, taken, if possible, from the county with which the regiment is, or ought to be, associated and connected; and let this, with a regimental monogram likewise perhaps, be worn as an ornamental and distinguishing badge in some conspicuous place. Different facings could then be abolished, and merged into one, viz., that most suitable and becoming. Perhaps the claim would then lie between green, black, or white.

But while favouring the continuance of simple distinctive badges for different regiments, the present system of each regiment having a button of its own, and a separate pattern of lace, involving, as it does, much trouble and expense, is to be deprecated.

The buttons, like those used by the Volunteers, should be made of bronze, so as to dispense with the constant furbishing required. At present each soldier has to carry about with him what is termed a "brass button," and brush for that special purpose. In like manner, with the badges generally, bronze might surely be substituted with advantage for the shining brass, which is not only vulgar-looking, but is likely to attract the observation of the enemy from a distance.

V. *Underclothing.—Trousers, boots, socks, and great-coat.*

I must now mention what in polite society is usually an "unmentionable" topic, viz., trousers. These, as at present shaped, are generally made too tight across the thigh and at the knee, so that firing in the kneeling position, for example, is rendered irksome and uncomfortable, unless indeed they mercifully give way, as not unfrequently happens during the rifle practice. Then, as to their colour. Surely black or Oxford mixture, as it is termed, is about the worst that could be selected for a man who has to march along dirty and dusty roads, or to take part in a review in the Long Valley at Aldershot, or dodge about in rifle-pits and trenches, often on all fours.

This colour shows every speck of mud or dust, and has besides the optical disadvantage of dwarfing the apparent height of men. In ordinary life we almost invariably have our trousers of a lighter shade than our coat and waistcoat, but in the Army this principle is reversed.

Black, as a colour, moreover, is too often made use of as a disguise for inferior cloth; and certainly the present material for the soldier's trousers is very indifferent. There is little or no wear in it, and it sadly lacks pliancy and freeness. In a wet day the lower part of the trousers, which are bell bottomed, is squeezed, as well as may be, into an impossible sort of straight cut leather legging—for all the world like a fire-bucket—reaching from the calf to the boot.

Thus it appears there is room for modification in the trousers, both

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as to shape, colour, and material. The last should be exchanged for a good light, strong, pliant tweed stuff: and as green, as has been already remarked, is the colour complementary to red, why not adopt a good shade of it, toned down by a judicious intermixture with a brownish-grey—something such as the Master of Lovat's mixture, for example. This would be infinitely better suited than black for setting off red jackets, and marching along dirty roads in.

With regard to shape, they should be made rather tight over the hip, with a strap and buckle behind, so that when engaged in any arduous work, such as using the spade or pick-axe, the braces, which I would still retain, might be let out, so as to free the movements of the chest and arms. During a long march this power of being able to ease off the braces, allowing the trousers to be supported by the strap at the hip, and so relieving the shoulders from their drag, is a great relief. Otherwise the trousers should be made large and roomy round the thigh, with ample width down the small of the leg, so as to be available at option as knickerbockers, like those of some of the metropolitan Volunteers; but to carry this idea out properly, the present nondescript legging should make way for a good brown leather legging, buttoning over the calf, so as to act as a greave, and extending down to the ankle, to which it should afford support; a legging, in fact, more such as Mr. Grant, in Piccadilly, supplies to English sportsmen for going through stubble fields or riding to hounds, or at any rate harriers in, for your English squire and yeoman farmer find it equally well suited for exercise either on horse or foot.

And here a question obtrudes itself which has recently received considerable attention, namely, the desirability and possibility in future wars of cavalry acting more or less as mounted riflemen. This, in effect, would be to revert to the original use of this arm. The so-called cavalry of England was formerly composed of some regiments of horse and the remainder of dragoons. These dragoons were, in point of fact, mounted infantry soldiers, equipped with long musket and bayonet, and taught to engage on foot. Should, then, this ancient method of fighting be reverted to, as is so strongly recommended by Sir Henry Havelock* and others, I maintain that the dress I have here endeavoured to describe and prescribe for the infantry soldier, would be found equally well-suited for mounted-riflemen or riflemen mounted.

Other notions as to the joint arrangement of trouser, legging, and boot will no doubt suggest themselves, but I cannot afford time to discuss them here, and I am inclined to think that on the whole the foregoing plan will be found most simple and practical. There is however a great deal I think to be said in favour of adopting a good brogue or broad-soled shoe, instead of the boot—the advantage of a spare pair of shoes in the kit instead of boots is very considerable, both owing to their being less bulky and less weighty—and there can be no doubt a man is more nimble and better fitted for running in a well fitting shoe than in any description of boot. The objection is that in loose

* *Vide* "*The three main Military Questions of the day*," by Colonel Sir H. Havelock, Bart. Longman.

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soil it is apt to admit stones and gravel over the side, this however could be to a great extent prevented by having a well shaped and closely fitting gaiter; by having the trousers to terminate in a band with a couple of buttons just above the ankle, this gaiter could be made high enough to cover this band, and to form a protection for the lower part of the leg. The gaiter might either be made of stout canvas sail-cloth or leather, with a stout piece of whale-bone running up the back seam, so as to make it fit close to the calf of the leg and give an elastic support to the ankle.

The sock should be of thick soft wool and well fitted to the foot. This latter condition is often apt to be lost sight of. Marshal Saxe, however, whose maxim as to soldiers' legs is so often quoted, gave this, as well as the make of the boot or shoe, great attention; and if these points were considered of such importance in times past, how much more urgent is the necessity for attending to them in the present day, when a soldier is called on to execute the chief movements of a field of battle at a speed hitherto reserved almost wholly for the bayonet charge. Under such circumstances it is self-evident that his shoes and his socks should be equally adapted to freedom of action with the least possible impediment or irritation. A boot which pinches the joint of the great toe or rubs a hole in the heel, and so converts every step into positive pain, will knock a good many miles off the distance a man can walk in the day, and a good many pounds off the weight he will be able to carry with any degree of ease.

Considerable pains have I believe been taken of late years by the authorities to improve and reconstruct the present blucher boot. It has been made higher, and broader in the sole, and there are no less than thirteen carefully selected sizes to choose from; but to reform a blucher boot is rather a thankless task, and one might as well try to make a good sailing vessel out of a ship whose original lines have been faulty, or a silk purse out of a sow's ear, as to make a really good comfortable boot out of the British blucher, the wearing of which appears to be reserved as the peculiar privilege of the British soldier. The original lines of this boot are faulty, and it must always be more or less clumsy and badly fitting: it generally lacks room at the toes, and has too much of that commodity at the ankles. That something is wrong, I think is shown by the fact that upwards of 70 men out of a battalion of 500, were laid up with sore feet marching from Aldershot to London, but this was a few years ago, and possibly before the reconstruction already alluded to.

The new army great-coat appears all that could be wished: although I hear the men complain of its weight naturally, more especially after its having got saturated with rain. The cause of this last complaint might be alleviated to a large extent, if not entirely obviated, by having the cloth well dipped in a solution of alum, so as to render it partially waterproof. The great difficulty is of course to reconcile this property with a due amount of ventilation. I understand the experiments are however, shortly to be made by the authorities with an invention which professes effectually to overcome this difficulty.

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VI. *Knapsack, Belts, and Pouches.*

At the risk of being deemed tedious, I must now say a word or two in regard to the present knapsack and accoutrements. A weight of 56lbs. or 4 stone, which is really about what our soldiers have to carry in the field, is no easy load even when packed and placed in the most convenient manner; but in the soldier's case, the circumstances under which this burden is supported, are the least favourable to the mechanical construction of the human machine. The weight so far as the pack is concerned, is so applied that it is thrown out of the centre of gravity of the body, and thus entails a greater expenditure of muscular force than would be required under a better arrangement. The knapsack straps cut under the arms and cause swelling and numbness of the hands, and the weight of the pack is thrown upon the great nerves and arteries of the arm-pit, so as to produce those serious disasters to the soldier's health and effectiveness to which public attention has recently been so much directed. But the effect on the health is not the only objectionable point in the present accoutrements and packs. They are irksome and uncomfortable to boot. The cross belt, when 40 or 60 rounds of ammunition are carried, is not only felt tight across the chest, but the pouch moves and bumps against the man, so that when doubling, soldiers are often to be seen vainly endeavouring to steady it with their disengaged hand, while as to the expense-pouch I can vouch for it, from my Hythe experience, that a "skirmishing practice," is rarely gone through without the soldiers losing some rounds of ammunition, owing to its faulty construction, the fact being that unless the flap is buttoned down each time after a round is withdrawn, it remains gaping open, so that when the soldier "doubles" up to his front rank man, one or more rounds are pretty certain to jump out.

Hitherto, likewise, all the careful training devoted to musketry is at present to a considerable extent neutralized, and rendered nugatory by the position of the knapsack and belts.

Then as to these belts themselves, can anything be more clumsy and unwieldy, or better calculated to catch the eye of the enemy in the field? They are in no way better, in fact, they are in no respect so good as plain brown leather belts, which age improves, and which dirt does not disfigure; they have to be constantly kept white with pipe-clay, adding another item to the field-kit (and, it should be remembered, that "every mickle makes a muckle"), and involving thereby much time and trouble. This killing of the soldier's time is alleged however, as one of their advantages; but, surely, in these days, a soldier's time would be more profitably occupied in the gymnasium, the garden, the library, or the workshop than in pipe-claying belts and burnishing up metals. The smart, clean look imparted by the pipe-clay vanishes in the field and they appear smudged and disfigured, nay, even after rain in peace-time, they present but a sorry aspect.

It would be waste of time to expatiate more than I have done, on the defects and short-comings of the present packs, pouches, and belts.

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The system thereby represented may virtually be considered as doomed, for in the able report recently issued by the Committee which Government appointed, "to inquire into the effect of the present system of accoutrements and knapsacks on the health of the infantry soldier," I find it stated, that of all the systems examined—and no less than twenty were brought under notice—the Committee conceived the English pack-system to be the worst.

But here I must take the opportunity of expressing my grateful acknowledgment and appreciation of the readiness with which I have been allowed access to the results thus far achieved by General Eyre and his colleagues. These results are by no means slight, and I can honestly say that it needed no consideration of the kind in question, to enhance the high estimate I have formed of the Committee's proposals. In this, after what I have said, I shall readily be believed, when I state that among other reforms contemplated, the Committee recommend the abolition of the knapsack, the pipe-clayed belts, the present cartouche-box, and expense-pouch, together with the possible adoption of good pockets in the tunic, at least in war time. This is not all, but it is enough to show that should their recommendations be carried out, a new era will be marked in the history of the equipment of our Army.

Under these circumstances I need offer no apology for here summarizing as best I can, the report in question, as it contains matter of much interest to the whole Army, and, I might say, to every Englishman.

General Eyre's Committee was appointed about three years ago, with the object already mentioned, and it sent in its first report during the year 1865. Since then however, public attention became specially directed to several of the points I have already dwelt on, notably so, to the species of corn found on the soldier's heart (the consequence, according to medical testimony, of the pressure of the belts and the strain put upon the body by the present heavy equipment), and to the increased rapidity with which military movements and manœuvres are now-a-days planned and executed, so as to keep pace with that free communication which is afforded by the facilities of steam and of the telegraph.

In their first report, the Committee advised that trials should be made of various plans in use in the armies of Europe and America; but defects were found in all of them. They therefore set to work to devise some better scheme, and in their second report bring forward another system, which is now on its trial.

The Committee fully appreciate the lessons to be learnt from the facts in connection with the late German war; and that the conditions of modern war require that the marching power and endurance of the soldier should be nursed in every possible way, whilst the introduction of the breech-loading system, and the consequent rapidity of fire thus obtained, demand that the men should carry a large amount of amunition.

The members of the Committee are unanimous that very little is needed to make up the "war kit" of a soldier, and that his efficiency and health suffer far more from his carrying too many things than from

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his occasional and temporary absence from any two or three articles of his kit; they therefore propose to limit his field-kit to the following articles:—

1 flannel shirt.
1 pair of socks.
1 towel.
1 pair of boots or shoes (the latter preferred).
1 hold-all, with its comb, razor, soap, and brush.
1 soft forage cap.
1 brush.

This differs from the present field-kit in the absence of trousers and blacking, and it is proposed that as the regulation boots are very bulky, as well as heavy, a pair of shoes should be substituted in the kit for the boots—a suggestion I, for one, heartily endorse.

This would represent a clear gain in the weight of the kit itself of about 2 pounds 5 ounces; but this is more than neutralised by the Committee's proposal that the quantity of ammunition carried, at least in the battle field, should be increased from 60 to 90 rounds.

The weight of a soldier's equipment—what he must carry, irrespective of the carrying-apparatus itself,—the rifle, the haversack for provisions, water-bottle, and blanket, would then amount to from 23 to 24 pounds, made up as follows:—

The kit, as given above.....	6 to 7 lbs.
The great-coat	6 lbs. (nearly)
Ammunition—90 rounds	9 to 10 lbs.
Canteen or mess-tin	1½ lb.
Bayonet	1 lb.
Total.....	23 or 24 lbs.

The apparatus recommended by the Committee for carrying the above has been reduced from 10 pounds 2 ounces (the weight of the present pack and accoutrements) to about 4 pounds 3 ounces, giving a difference of 6 pounds in favour of the former, and making a total weight for kit and carrying apparatus of about 27 pounds. To this has to be added the weight of the rifle and slings—9½ pounds, and the man's clothes—10 pounds; so that, after all, the total weight (46½ lbs.) is a heavy one.

It is proposed that the greater part of this weight, or what constitutes the kit, as before detailed, should be carried upon the yoke principle of Sir Thomas Troubridge, identical with that adopted by milkmen, by which the weight is borne by the shoulder-blades, and direct from the centre of gravity, the yoke itself being of leather (*vide* Figs. 3, 4, and 5). The weight of the ammunition is distributed in front in two long and narrow pouches, made of soft leather, each capable of holding 30 rounds, while of the remaining 30 rounds to be provided for, 20 go with the kit in two small pouches, and the other 10 rounds (loose) either in an expense-bag, worn on the right side, or, "*in a pocket below the waist-belt in the man's tunic*, thus avoiding an extra article of equipment."

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The pouches in front project scarcely at all from the body and are easily accessible, and, although attached to the waistbelt, the weight is borne entirely by the shoulders, and therefore not by the ribs and stomach; in addition to which the principle of balance is introduced by making them act as a counterpoise to the weight behind. Of course during peace only one pouch with the usual 20 rounds would be used, the other pouches being easily distributed in the time of war.

With regard to the manner in which the kit itself should be carried, the framed knapsack is condemned, it being stated, that though the frame gives an appearance of neatness, it is at the expense of increasing the weight and preventing it being suitably adjusted. A kit-bag is, therefore, to be substituted, placed low down, so as to leave to the muscles of the neck, shoulders, and shoulder-blades, the freest action, and more perfect expansion to the lungs. The weight is distributed in three directions. "By means of straps passing to studs fixed on the yoke-strap in front, and to the yoke at the back of the neck, its chief weight is brought on the yoke. It rests, secondly, in parts on the sacrum, or strong connecting bone of the hip, and at pleasure it may almost be carried there to relieve any pressure of the yoke; it is also strapped to the waistbelt in front, and is thus partly borne by the belt, partly by the yoke" (*vide* Fig. 3). I have given here the exact words of the Report. So great is the ease with which the kit may be carried in this manner, that the Committee feel confident, that provided its contents are limited to the extent they suggest, no man would feel distressed, or tempted to throw away his kit, even in the heat of action, and certainly, so far as its merits have as yet been tested, this anticipation, however sanguine, would almost seem to be corroborated. Nothing can be more satisfactory than the reports that have been sent in, both from Colchester and Hythe, where it has been for some time on trial. At the former place, in reply to Colonel Tidy, one man said, "I can not only march with ease, Sir, but I can run and jump with this pack:" and I have it from General Hay himself, that it is in his estimation a great success, that its adoption would materially improve the shooting of the Army, and that, as for the men, they pronounced so strongly in its favour, that they parted with it for their old friend, the square box-knapsack, with the utmost possible reluctance.

The great coat is folded in a square and attached to the yoke by a strap at the back, which will also carry the canteen (*vide* Fig. 5).

It is suggested that the haversack, if made a little smaller, might be suspended from the waistbelt, or that its necessity might be done away with altogether in time of war, *by having good pockets in front of the tunic.*

It is intimated that a better contrivance ought to be substituted for the present water-bottle, which is stated to be heavy, and very inconvenient and objectionable in every way, and in this I think every soldier will agree.

"Good black bridle leather" has been employed for the yoke and straps, the Committee rightly fearing that buff would yield too much

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to the rain, and that its inconvenience on service, when pipe-clay cannot be procured, is also thus avoided.

This comprises the substance of the report, and the advantages claimed for the new system therein proposed may be briefly summed up by stating, that the burden is diminished by several pounds, notwithstanding an increase of thirty rounds in the quantity of ammunition carried, the weight distributed on correct mechanical principles, and all injurious pressure removed from the lungs and arms.

I understand that a difficulty as to the straps and belts being black has presented itself, it being found that the dye is liable to come off to a certain extent. The Committee appear to have adopted black in preference to the natural colour of the leather from a desire to maintain uniformity, for in the words of their report it is stated "a regiment could then be kept in uniform tint, which is not the case with brown leather." But surely this is splitting hairs, and making a mountain of a molehill; it is a very easy matter indeed to make a new bridle or saddle look like an old one, and so the old and new brown leather belts could by a similar process be made as like each other as two peas, if we must have it so for uniformity's sake.

The point to which most exception to the proposed arrangement might be taken, appears to be the position of the mess-tin, at the top of the great coat, just behind the soldier's neck (*vide* Fig. 5). It certainly appears to be in the way there, besides having a very awkward look. I should have thought it could have been carried much better, on the centre strap of the valise, so as to lie flat upon it, but the objection to this I am told is that, with our close formation in the ranks, it might come in the way during the formation of fours, for example, but I think this may be got over in a way I will presently suggest.

Meanwhile it is obvious that this is a mere matter of detail; what is now wanted is that General Eyre's plan should receive a more extended trial, and this, I believe, has been decided on by the authorities. If the new system be found good after a fair and sufficient trial, let it be adopted, or if any better can be brought forward let it be replaced, but do not let this opportunity of remedying the present evils be coldly discarded, simply from an idea that the new system deviates too much from the existing patterns.

I have been induced to make these remarks, because it appears that objections have already been raised—even at this stage—to the yoke-bag, on the ground that it departs too much from the conventional model, and that it is too great an innovation on the traditional equipment of the army. But should the yoke-bag possess even one-half the practical advantages anticipated, it cannot be believed that any such opposition, owing to its novelty of appearance, can for one moment be allowed to prevent its adoption.

Having felt bound to say this much in explanation and favour of the new yoke-bag and system of accoutrement, I will now offer for consideration what I conceive would form a considerable improvement in connection with it; nor is there any inconsistency in my so doing, inasmuch as the amendment I propose suggesting is in entire har-

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mony with the general principles of the new system, and merely one of those changes in detail which will doubtless present themselves while the new plan is still on trial.

In the first report of the Committee it is well remarked in reference to one of the packs tried, that "it seemed absurd to weight a man with a box weighing 5½ lbs., to enable him to carry a weight of 7½ lbs.," but in principle the same argument holds good, although in a greatly modified degree, in regard to the new yoke-bag itself, and a kit of merely 6 lbs. weight, as now proposed. I have always felt that it would be most desirable if the weight of the medium, whatever its nature, employed for carrying the kit, could likewise be made to subserve some good practical purpose. This I have endeavoured to effect by substituting in lieu of the kit-bag a bed-haversack, consisting of a rectangular piece of waterproof sheeting, 6 feet 6 inches long, by 2 feet 6 inches wide, having a pouch at each end to contain the kit, each article of which is kept in its place by webbing or elastic, the open ends of these pouches being fastened and secured by toggles (*vide* Figs. 6 and 7).

Thus, taking the field-kit recommended by General Eyre's Committee as my standard, in one pouch I place 1 pair of shoes, 1 hold-all, and 1 brush, and in the pocket at the other end 1 flannel shirt, 1 towel, 1 pair of socks, and 1 forage-cap; the great coat is rolled up lengthwise, and attached to fastenings, placed for the purpose along one side of the waterproof, and of course inside (*vide* Fig. 7). The whole is then carefully rolled up, and fastened with a strap, or if preferred with a cord by means of eyelet-holes provided for the purpose, so as to form a long waterproof roll (at no part perceptibly thicker than a great coat rolled up in the ordinary manner) which serves to act as a hold-all on a large scale for the soldier's kit and great coat (*vide* Fig. 8). On the line of march this roll would be carried diagonally across the left shoulder, horse-collar fashion, the ends being fastened together at the right side by a simple strap and buckle (*vide* Figs. 9, 11, and 12). By this means the knapsack difficulty is got rid of, and the soldier is at the same time supplied with the inestimable advantage when camping out, of a waterproof ground-sheet to lie on. This alone would be the means of saving many lives in a campaign.

When used for sleeping on, the whole kit would be placed in *one* pouch, so as to act as a pillow, while the feet might be protected by the pocket at the other end (*vide* Fig. 6), the great coat, being rendered waterproof as before mentioned, being used as a bed-cover. At other times this waterproof could be employed as a rough and ready waterproof cape, to be worn over the great coat or otherwise (the kit still being retained in the pockets, distributed as before described); for this purpose armholes, arranged so as not to interfere with its waterproof qualities, have been provided, together with a small collar, to make it fit close to the neck, and straps and buckles for fastening it together (*vide* Fig. 6, AA).

Occasionally the men might be allowed, with obvious advantage, the waterproof to practise their first-class firing on in the lying-down position now sanctioned, in the case of the ground being wet or damp.

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so far as the preservation of their health and clothes is concerned. Or again, on emergencies, when combined with one or two others by means of the eyelet-holes and straps, these sheets might be made to act as an *extempore* shelter-tent, piles of rifles supplying the place of tent-poles.

In point of weight, there would be little or no difference between this bed-haversack and the kit-bag, &c., proposed by General Eyre's Committee; and the cost, when made up in large numbers, would not be considerable, although for a really good article 8*s*. or 9*s*. would not be deemed too much, I imagine.

Having thus provided for the kit and great coat, I propose that all the other weights, including ammunition, mess-tin, and canteen, should be arranged, on a principle of balance or counterpoise round the waist-belt, which by the plan of carrying the kit here suggested, is left quite clear, and owing to the admirable manner in which it is supported from the shoulders by the yoke, is obviously the natural place for attaching these weights to. The present water-bottle might be replaced by one of metal, or stout glass covered with leather, shaped after the manner of a hunting flask, so as to conform slightly to the shape of the body, and the mess-tin might be altered in its shape on a similar principle. The ammunition would be disposed of in the manner proposed in the report already quoted, except that I would dispense with the expense pouch in favour of the waterproof pockets provided in my Norfolk jacket (*vide* Fig. 11), and in like manner the breast pockets could take the place of a haversack.

My original idea was to use the bed-haversack in conjunction with a set of belts devised by Colonel Luard. These belts have the merit of great simplicity, being made on the principle of a pair of leather braces supporting a broad waist-belt by means of studs, from which they can be readily detached. The weights, &c., would be distributed round this waist-belt in the manner already described, and supported from the shoulders on a principle similar to that of the yoke.

I anticipate that exceptions will be taken to my proposed mode of carrying the kit and great coat on two grounds, the first being that a roll of this kind would embrace the chest and back too much, and so re-produce some of the evils of the old system. In answer to this I have merely to say, that in reality the roll is so open that it seems to create little or no pressure of the kind referred to, while the weight is all but entirely supported by the shoulder; and also that the men themselves, when allowed a choice, prefer apparently to any other, this horse-collar manner of carrying the great coat. Both the Prussians and Austrians, I understand, carry it so. I have likewise the assurance of Dr. Parkes, of Netley Hospital, that in his opinion there would be no objection, on sanitary grounds, to this mode of carrying the kit. However, if that manner of carrying the roll was really found objectionable, it could very easily be folded up in a different and less extended shape (*vide* Fig. 10), and carried on the yoke at the back where the valise now is; the great coat being taken out and carried in the manner proposed by General Eyre's Committee (*vide* Fig. 5).

The other objection likely to be urged is of a different kind, and one

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to which several other details in the new equipment mentioned may appear more or less open, as, for instance, the suggestion of putting the mess-tin at the back of the valise. It is this, that these innovations and the mode of carrying the great coat and kit suggested are incompatible with the maintenance of that close order which is so much insisted on, especially when our men are working in line and performing the manual and platoon exercises. But with regard to this, breech-loaders may be said to have all but annulled the platoon exercise, and the sooner the manual exercise is correspondingly modified the better. Why, for instance, should the "long shoulder," as it is called, be retained? The Volunteers who are armed with the long Enfield, I understand, invariably drill as with the short rifle, and so avoid that awkward movement. As to the soldier maintaining that delicate touch in the ranks "by feeling the thick part of his "neighbour's arm below the elbows," I have on a former occasion in this theatre advocated its abandonment for a freer and more healthful formation.* By compelling the soldier to keep his arms rigidly at his side, we diminish his strength, lower his capacity of endurance, and greatly retard his rate of marching, while at the same time we prevent him, by this close formation, from giving full effect to his rifle when firing, or to his bayonet in a hand-to-hand encounter. The soldier soon finds out that in actual practice, in making an advance on rough ground, or as soon as a gap or two has been caused by the enemy's shot, the maintenance of this "delicate touch" is a physical impossibility; and having discovered the impracticable nature of one tenet in the drill taught him in the barrack-square, he is too apt to infer it is so with all. He thus loses confidence in his instruction and instructors, his sense of discipline is impaired, and he is no longer so good a soldier. The simple moral of all this is, that we should not in time of peace teach soldiers that which disappears at the first touch of real trial in time of war. Let the touch in the ranks be by the elbow as men stand naturally—30 inches say instead of 21—and when on the march let men move more by the instinct of the eye as to distance and dressing, just as keepers and under-keepers beat a cover in a loose yet regular line.†

VII. *Conclusion.*

This, stated very roughly, is the nature of the modification, I think, should, if possible, be attempted in connection with the yoke-system; but suppose every difficulty overcome, either as to this modification or to the yoke-bag plan of General Eyre's Committee, the fact still remains,

* *Vide* "Coast Railways and Railway Artillery."—*Journal of the Royal United Service Institution*, vol. ix.

† Since these words were written and delivered, the Field Exercise for 1867 has been promulgated, and the position of the soldier henceforth is thus defined:—"The arm to hang easily from the shoulder, the elbow slightly turned out, the hand open, with the knuckles inclining to the front. The average front of a file to be 24 inches." This so closely harmonises with the views expressed above, that the difficulty there referred to, may be said no longer to exist.—A. W.

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that the soldier will have to carry a weight when in the field not far short of 50 lbs., and the question will doubtless still obtrude itself, can any system be devised whereby the soldier shall never be divorced from his baggage, and yet be free from the toil of carrying it? General Eyre's Committee meet this question by a decided negative. "To leave the soldier, they say, without some articles of his kit on active service, would not only deprive him of comfort, but would be injurious to his health; while the attempt to carry his war kit for him in carts, &c., would be simply impracticable in nine cases out of ten." It cannot indeed be wondered that they should take this view of the matter, for the problem is one fraught with the greatest difficulty, and is one which would require both more time and ability than I can devote to its discussion.

But although I am inclined to agree at the present moment, and with our present light, in the wisdom of the Committee's conclusion, I cannot forget that this word "impracticable" has often been applied before now by Committees to matters which in the end have come to pass—breech-loaders may serve as an example. I cannot forget that "force used is force expended;" that if a horse is over-handicapped he will lose the race, and that what a pound is to a horse an ounce is to a man. Nor should what has actually been accomplished in this respect be lost sight of; witness Stonewall Jackson's flank marches, and what the Garibaldians did on more than one occasion: how in India our men literally carry nothing but their rifle and ammunition: what the Sardinians effected in this way in the Crimea, and what the Prussians have more recently brought to pass from availing themselves more freely than has hitherto been done of the modern facilities of transport and of telegraph.

If it be an axiomatic truth that, in modern war, no army can move without artillery, could not the same roads be made available for bringing reserves of clothing, &c., to the front, while the soldiers themselves might carry some of their ammunition, for which transport had formerly to be provided? Is it not indeed possible that the day may yet come when traction-engines may be seen doing the work of multitudinous horses in the rear of a field of battle?

Meanwhile we must be content with General Eyre's salutary compromise that although men must carry a war kit, this kit must be reduced to the smallest possible amount. In this, I think, we shall all heartily concur.

I fear I have trespassed already only too much on your time and your patience. I would merely say, in conclusion, that although the remarks I have here hazarded have special reference to the infantry soldier of the Line, the principles involved apply equally to all branches of Her Majesty's service. These principles are simply, that efficiency should be the primary, and appearance the secondary consideration in the soldier's dress, but that the latter may be made perfectly compatible with the former, and that a man may be soldier-like, and yet be clad in an easy, sensible dress suited to his work, just as a man may be sailor-like; and to this I would add the assurance, that whatever the nature of these remarks, or whatever

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their merits or demerits, far from having been offered in any spirit of dogmatism or opiniativeness, they have, on the contrary, been prompted purely and solely from a wish to have this subject thoroughly ventilated, and from a desire, if possible, ultimately still further to promote the health, the comfort, and the efficiency of the English soldier—a desire in which, I am well aware, none more fully participate than the present Military Authorities themselves, who, I sincerely believe, to quote the words of His Royal Highness the Duke of Cambridge himself, "in the course they adopt, are not influenced by impulse, favour, or affection, but solely by a desire to maintain this country in the high and noble position she has so long enjoyed."

The CHAIRMAN: Gentlemen, at this stage, I believe it is usual, if any one wishes to make any remark, or to put a question on the subject of the lecture, to invite him to do so. Captain Walker will have the advantage of the intelligent criticism that usually follows proposals that are laid before this Institution; and, possibly, he will be able to reply to any objection that may be made.

Colonel EVELYN: As no gentleman appears inclined to address the meeting, and as it is usual that some remarks should be made after the papers read at the Evening Meetings, I venture to rise, not as an opponent of Captain Walker, for I agree with him in principles if not in details, but to amplify a little his remarks. I am glad to hear that the Government intends to do away with the infantry shoulder-belt—a thing as thick as a trace, to which the cartouche box is suspended in a manner to allow the 60 rounds of ammunition it contains, to play the devil's tatoo in the soldier's rear whenever he attempts to double, annoying him, and destroying the cartridges. Captain Walker observed that our order was a great deal too close,—that 21 inches per file was not enough. I quite agree in this. Men cannot march elbow to elbow, except on a bowling-green; and when we consider that an attack now-a-days would usually be on an entrenched position, where the enemy would be under cover, and consequently not to be fired at, it is manifest that a line should be able to double, which it cannot do at the present close order of files. I am glad to say that this has, to a certain extent, been set to rights, for the new regulation is to give 24 inches per file, instead of 21. This is a step in the right direction, which might with advantage be increased. When we consider the probable great extent of the line of battle of the future, rendered necessary by the increased range of firearms, it seems likely that the fate of a battle may often depend on the relative speed with which the rival troops can get over four, five, or six miles of ground during the action. If the object of each General is to get a larger mass of men than his adversary to bear on a certain point, it seems that a line seven or eight miles in length can only be strengthened in any part by long marches from the Reserve; it would simply be a race between the two sides, to bring up men to reinforce a line several miles off. An extra ounce of weight, borne by a soldier, might be fatal. And this consideration applies to cavalry as well as infantry. The time has therefore arrived when we should discard shabracques, sabre-taches, bearskins, highland funereal plumes, and similar absurdities. It is probable that many Officers, young Officers especially, will disagree with me in this, because they think a soldier should take a pride in these things. But a soldier can be induced to take great pride in the devise of a button, or a little bit of lace. It is not ornament that is objectionable but cumbrous ornament. Why, then, load a soldier with things that are incumbrances, simply for the sake of effect?—effect that is always lost, for if you neglect the useful and appropriate, you cannot attain the ornamental. Take an infantry soldier of the present day in marching order, can any one say he is a particularly picturesque object, with his ugly hat, his short tunic, and broad shoulder-belt? Ladies, and some gentleman here, may never have seen the thing provided for British soldiers to carry water in during the march. It is a wooden barrel slung on a shoulder-belt. I do not know who invented it, but I should be

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sorry to be that man. In addition to these, the soldier has a third belt across the shoulder for his haversack, a canvas bag, into which rain passes without hindrance. If he puts his bread into it, it becomes a sop, and a very dirty looking sop it is when he has to eat it. I have no hesitation in saying that the old cross-belts going over both shoulders, was a better arrangement than the present, for, at least, it was not lop-sided, whereas now the man is lop-sided. He carries 60 rounds of ammunition on the left shoulder, and is taught to carry his rifle on the same shoulder too. When I first joined the militia some years ago, we had a shoulder-belt and waist-belt as at present; but, in addition, we had a short strap about an inch long connecting the pouch to the waist-belt behind; so that the weight was supposed to be divided between the shoulder-belt two feet long, and another little strap about an inch long. Suspend any weight on the wall opposite, and try to divide it between a rope two feet long, and another an inch long; it will be found almost impossible to apportion the lengths so as to divide the weight. I think we ought to have nothing over the shoulders except the knapsack straps. The French soldiers are accoutred in a simple and efficient manner. They have only a waist-belt, which, however, ought to be a hip-belt, not a waist-belt; it ought to be below the waist, resting on the hips, the proper place to carry a weight. We have seen a mountebank supporting a six-pounder on his hips. As to yokes or braces across the shoulders for supporting the ammunition, they are quite unnecessary. The French have attached to the tunic at the left side, a little piece of cloth called a *suspensoir*. It laps over the belt, and is attached to a button above it. The belt rests on it, and it will support a great weight. I used to be very fond of shooting when I was at the Cape, and I have carried more than 100 bullets, an axe, a powder-horn, and many other things, all suspended round my waist. I have carried them on horseback and on foot, and have slept with them around me. I have carried them many more hours than a soldier on the march, without inconvenience, and even without the support of *suspensoirs;* far less can there be any necessity for a shoulder-belt. Our packs are badly placed, too high on the back, and they are, with the great coat, much too thick. The weight of the pack should be along the spine not across it. There used to be an old saying, "You must not interfere with the small of the back;" and that expression became stereotyped, till the authorities were afraid to have a pack that came down low on the back, so they made it very broad across the shoulders, and very narrow in the length of the man's back. It amounted, in fact, to placing a weight at the upper end of a flexible cane (to which the human spine may be compared), instead of distributing it vertically along it. The pack should extend along a man's back, and not across it. As the infantry soldier is a marching animal, I consider no part of his dress of more importance than his shoes. Wellington boots are an abomination either for cavalry or infantry. There is another stereotyped expression with reference to boots and shoes. People say, "you must "support the ankle." Now what is the ankle? The ankle is a joint; it requires freedom, not support. Who ever heard of a man running a race requiring support to his ankles? he wears pumps. Whoever heard of opera dancers requiring support for their ankles? They require perfect freedom. There is nothing so good for marching or running, for jumping or climbing, as a low, broad shoe, with a good, close-fitting gaiter. It is a mistake to suppose that there is any inconvenience from the strap attached to the latter. I have spoken to French soldiers about it; and they say that the canvas gaiters are capital things, and that the strap that goes under the foot, lasts longer than the sole of the shoe. They do not, however, like their jambières,—hard leathern things which make the calves of their legs ache, and which would not be required at all if the gaiters were made longer. In Africa, when the Officers allow it, the men leave off wearing the jambières, and let down the legs of their knickerbockers to the ankles,—thus forming a light and easy marching costume. I hope that a few years will bring about a great improvement in the equipment of our cavalry and infantry; and that we shall no longer see the members of that excellent corps, the Guards, hopping about on a Sunday, with their trowsers dangling about the ankles, and balancing huge bearskins on their heads. The eye may become accustomed to anything; but if we were to see a bearskin cap for the first time, it would appear as fantastic and grotesque as anything

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in Mr. Catlin's pictures of the North American Indians. I have no doubt, however, that the march of intellect will induce a great change in these respects.

Captain WALKER: I am glad to find that my views, in the main, have found so able a supporter. I am very much interested in what Colonel Evelyn has said. There is merely one point with reference to the weight-carrying power of the soldier that has not been adverted to, and that is, the disadvantage accruing from our present bore of rifle in connection with its conversion as a breech-loader. I do not wish to say a word now against the expediency of the conversion of the Enfield rifle into the Snider breech-loader. I believe, as a matter of temporary expediency, it was wise and prudent, and has, in the main, been attended with most satisfactory results. But I do think that that which constitutes a great drawback to it, should not be lost sight of—in connection with the weight carried by the soldier; inasmuch as, instead of the weight having, in these particulars, as to the rifle and ammunition, been decreased, it has actually been increased, to the extent of, at least, a pound in weight; whereas, on the continent, we find—in Prussia, for example—that that remarkable man, Herr Von Dreyse, the inventor of the needle-gun, is introducing a rifle which weighs 3½ lbs. less than the needle-gun with which the Prussian army won the battle of Sadowa. So likewise in France, we find that with the Chassepot rifle the soldier can absolutely, owing to the small bore of that arm, carry 90 rounds of ammunition for our 60, or 135 rounds for our 90. Now any one who has read what occurred at Inkermann—how at the supreme crisis of that desperate struggle, our Guards found themselves without a single round of ammunition—will appreciate the importance of this disparity in the number of rounds carried, weight for weight, by the French and English soldier respectively. I think it right to draw attention to this, although I cannot imagine that the Committee at present sitting at Woolwich, under Lord Spencer, will lose sight of it, for the day has gone by when it was held that it required a large bullet to "stop" a man, as if he were an elephant or other large game. It is now pretty generally admitted that where the human frame is concerned, but a small bullet, a mere bodkin's point as it were, is needed to produce the result required and place a man *hors de combat*; and it is acknowledged that a wounded man is a greater impediment than a dead one, inasmuch as the former demands the attention of two or more men:—

> "Indeed in battle, better maim than kill—
> "The dead may lie there, but the maim'd must still
> "Cumber the living, and the 'sick-list' fill."

Another point to which much weight has been attached in connection with the alteration of the dress of the army, was not referred to by me in my lecture. It has been asserted that the effect of dressing the British Army on the principle that a recruit is a man of ordinary common sense, who has adopted his calling from the same motives as those from which other men adopt theirs, would be "to diminish "recruits in any agricultural district by 50 per cent., and in a town by 75 per "cent. at the very least." I cannot but think that such an estimate must be a great exaggeration, *even supposing* that the dress of the Army, when made more easy, more what you might call serviceable, was not compatible with good appearance. On another ground I meet this. Assuming, for the sake of argument, the correctness of this estimate, should we, I would ask, knowing what we now do as to the detriment which ensues to the health of the soldier by thus appealing to the predilection of half-educated men for a gaudy dress, employ this as a fulcrum or agency in recruiting? Should we try to entrap men as we do trout by the tinsel of an artificial bait, when we know that the wound imparted by the barbed hook has its counterpart in the subsequent injury which is inflicted to the man's health and strength, according to medical and other competent authorities—by the present system of dress and accoutrement? But I believe that this, in reality, is exaggerated in another way. I believe that in the present day of newspapers, of all but universal education, and practical good sense among the masses, your Thomas Aitkens—the John Noakes of the army, looks beneath and beyond the recruiting sergeant's scarlet tunic and "bunch of gay ribbands," and inwardly, if not avowedly, asks how his dress, with its paraphernalia of thick leather stock, pipe-clayed

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belts, pouches, and knapsack, is likely to affect the comfort of his future every-day life. But in point of fact, this whole line of argument, as to recruiting being injured by a reform of the soldier's dress, is demolished by what I have already maintained, viz., that a dress may be perfectly easy and serviceable, and at the same time perfectly compatible with good military effect and costume; and to say that you make a "rowdy" of a man by altering the cut of his coat, and giving him pockets, is as absurd as to say that a man out hunting ceases to be a gentleman because he wears a red coat shaped like a shooting jacket.

The CHAIRMAN: These are days of reform, and whether ultimately General Eyre's soldier, or the compound soldier recommended by Captain Walker, may find favour in the eyes of the military authorities, or whether any other pattern may be adopted, is a matter of uncertainty. We might have had more numerous expressions of opinion this evening, but I confess, I rather sympathise with the reserve of those gentlemen who keep their opinions for further consideration. I am disposed to do the same—to think upon what Captain Walker has said, before I express myself in more decided terms.

APPENDIX.

(Copy of Letter from Messrs. Ellwood and Sons as to the comparative advantages of Cork and Felt as a material for a Military Head-dress.)

London, Blackfriars Road,
July 2nd, 1867.

Dear Sir,

* * * *

We have for many years past made hats and helmets, both wholly of cork, and of cork in combination with other materials, and from experiments we have tried at various times we have found that cork by itself is totally useless as a head-dress, as it has not sufficient strength and toughness to withstand the most careful wear. Cork may be combined with cloth, by shellac and other gums so as to make a hard substance, similar to the body of a velvet hat; but we do not think that, by any means, the best material for a soldier's helmet. Cork may also be combined with cloth by means of India rubber, and it would then be comparatively soft, and might be doubled up or crushed without losing its original shape, exactly in the same manner as a mackintosh cloak may be, with precisely the same qualities as the mackintosh goods possess, viz., perfectly waterproof, not porous, to allow perspiration, to evaporate, and quite air-tight—all very useful qualities in some cases; but we do not for a moment suppose that any one would consider a mackintosh coat and trousers the best clothing for a soldier in a tropical climate, so we cannot understand why it should be the best material for a head-dress; and we all know how cork will keep the air out of a bottle of port wine, or in a bottle of soda-water, exactly the reverse in both cases of what is required with a soldier's helmet.

Felt is impervious to water, but not to air. It is a good non-conductor of heat (as proved by its being used for covering steam boilers and pipes), and when perfectly manufactured is not liable to be injured in any way by rain. Of course, a very low priced felt will not stand so much rain as a better one.

We could make *soft felt* helmets that could be folded into any form without losing their original shape. They could be used as pillows, and yet be quite impervious to rain.

We are, Dear Sir,
Yours obediently,
(Signed) J. ELLWOOD & SONS.

To Captain Walker,
&c., &c.

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The Journal
OF THE
Royal United Service Institution.

Vol. XI. 1867. No. XLVI.

LECTURE.

Friday, April 5th, 1867.

Captain M. S. NOLLOTH, R.N., in the Chair.

THE ECONOMY OF THE CHINESE ARMY.*

By J. Lamprey, M.B., F.R.G.S., Surgeon 67th Regt.

The numerous fortified cities and towns met with throughout China, and the Great Wall itself, must be regarded as sufficient evidences of the necessity the Chinese have had for a military organization to sustain the Government of their country, and their written history informs us that they not only had to defend themselves from external enemies, but that their continent being divided into several independent states, they were continually at war with each other, and that when they became a united nation, they extended their empire far beyond its proper geographical limits by their military prowess, so that we find its sway at one time extended from the Caspian Sea to the Straits of Sagallien, and reached as far south as almost to touch the Indian Ocean.

It will give some idea of the extent of the Chinese Army in the sixteenth century, if we refer to Mendoza, who enumerates the quota of horse and foot for which each province was accountable, at that period. He says, "the Province of To Lan Chia, which is that which "bordereth on the Tartarians, with whom the Kings of China have "had wars (as aforesaid), hath two millions and eight hundred "thousand footmen, and two hundred and ninety thousand horsemen, "and are the most famous and best in all the whole Kingdom, for that "they are brought up in the use of armour from their youth, and "many times exercised the same in times past, when they had their "ordinary war with their borderers the Tartarians." He then sums up the whole as follows: "By this account, it plainly appeareth that

* The illustrations to this Lecture are graphotyped from sketches by the author.—Ed.

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"all these provinces (which may better be called kingdoms, consider-
"ing their greatness) have five millions eight hundred and forty-
"six thousand five hundred footmen, and nine hundred and forty-
"eight thousand three hundred and fifty horsemen. All the which, if
"in valour and valientness might be equalled unto our nations in
"Europe, they were sufficient to conquer the whole world." Du Halde is more moderate, he says: that in the seventeenth century, "they "reckon more than eighteen thousand mandarins of war, and above "seven hundred thousand soldiers distributed among the forts, cities, "and fortifications belonging to the several provinces, and along the "Great Wall." And what is the present condition of this great nation, who counted their armies by thousands, while we were hunting the wild beasts of the forest for our subsistence, and were on a level with savages? A few years have hardly elapsed since a mere handful of men from our island home landed on the shores of that distant continent, marched to their capital, made the Emperor of three hundred millions of people fly from his palaces, and submit to terms of peace; on all sides civil wars are desolating the land, the aid of foreigners has been sought to suppress revolt, and the nations whom they affected to despise, have been entreated to take in hand their army, whose uselessness they acknowledge, and teach them the art and science of war.

Our wars with China up to the culminating one of 1860, had taught us to treat the Chinese, as an enemy, with contempt, not so much from the deficiency of pluck in the individual Chinaman as a soldier, as from the want of military appliances and science, to which, numbers however individually constituted, must succumb; for instance, even in the earliest wars with the Chinese, our appliances of the period, were as much superior to theirs, as our present appliances are superior to our own of that particular time, in other words our muskets and artillery were as much superior to the matchlock and rusty old cannon of the Chinese, as our present breech-loading rifle and rifled cannon are superior to the old flint musket and smooth bore carronade of former days. It was curious to remark, that while the equipment and organization of their army apparently remained stationary, each war found their defensive fortifications better planned, and placed in more commanding positions than in the preceding ones; for instance, the flanking defensive forts on the high ground on the north side of Canton, which our military commanders did not disdain to garrison, and the Taku Forts, both which would probably have withstood the attack, if the Chinese had not been over-matched in artillery, and in arms of precision. It was this aptitude for defensive warfare that produced the Great Wall, which answered the purpose it was intended for, namely, to keep the Mongolians from making incursions into China, and to save the expense of maintaining a standing army along the extended frontier. So likewise the defensive walls surrounding their cities, those marvellous memorials of their skill in masonry, no doubt answered the object they were intended for, also, namely, to make their cities and towns serve as places of refuge, to which the people could resort during the incursions of the bordering states, or to preserve the civil

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magistrates and Government in political disturbances of the nature of civil war, &c. A glance at the map of China shows how numerous these walled cities and towns are throughout each province.

The plans of construction of the defensive walls of their cities have a remarkable resemblance to each other. The ground plan is generally a square or a paralellogram in form, each side wall being perfectly straight and facing a cardinal point. This form holds good more especially in the north of China, but in the southern and middle provinces there are many cities we are familiar with, where the outline of the ground plan is very irregular. These walls are generally about thirty feet in height, and have an inclination of about ten degrees inwards as they ascend. They are for the most part built of bricks of rather large dimensions, for instance, those forming the wall of Pekin, were eighteen inches in length, nine inches wide, and four and a half thick. Those in the wall at Shanghai were fourteen inches long, seven inches wide, and three inches thick. The top of the wall is crenelated, and is sufficiently raised to form a breastwork, above the banquette formed in the inside, by the earth dug out in making the circumvallating ditch in front of the wall, and distant from it about 20 to 30 feet (Figs. 1, 2). The ditch is about 40 feet wide, and deep enough to form a canal on which there is often considerable traffic, if the locality admits of much water communication; but in most of the cities I visited in the north of China, the ditch surrounding them had no water in it, or was filled up with sand, or as in the Tien Tsin ditch, was made the cloaca maxima of the city, and was filled with its filth. In measuring the city wall of Shanghai, I found the width of each embrasure at the top of the wall to be twenty-two inches, and the distance between the embrasures about eight feet; in this part there were small square apertures about eight inches wide, for use as spy-holes, or embrasures for jingals and matchlocks. The large embrasures being open at the top, would imply that they were intended for bowmen, to enable them to put the bow in such a position as to hit objects close to the wall below.

Guns are generally mounted before embrasures over the city gates, or on the projecting bastions or flanking defences, a suitable platform being raised to the level of the ordinary embrasure. The walls of their cities vary in length from a few hundred yards to several miles on each side; and where flanking defences are not constructed at the distance of every eighty yards, their outline is uninterrupted throughout, unless at the centre, where the gate is usually found.

The "Ta Tsing gih tung che" gives the following measurements of the cities of Peking, but only gives the whole circumference, not the length of the sides:

Chinese City	40 le in circumference.
Tartar City	18 „ and odd „

The Chinese city is described as being 28 le long, and the original plans as being 70 and odd le in circumference. The Tartar city is nearly square. The Chinese city is considerably broader than what we should call its length. The above 28 le refers to what we should call the breadth, that is from east to west—a le is

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equal to one-third of a mile. The wall of Pekin has masonry on the inner as well as the outer face of it.

The city gates are defensive works in themselves, and are apparently more capable of resisting attack than the wall itself, as if this was the only point an enemy could think of attacking. They are generally semicircular in outline, and made of the same material as the wall. The entrance is by an archway formed in the angle where the structure springs from the wall. There are two gateways, one an inside, and the other an outside one. In a city in the north of China, I observed three gateways, before passing the inner gate. These gates are made of stout wood, faced externally with thin sheet iron and nails with large heads. They open in the centre, and are fastened by a bar behind (Figs. 3, 4).

Over these gateways there are buildings of such a height as to command a good view of the city and surrounding country. They are intended for guard-rooms, and usually consist of an upper and lower story; though those over the gates of Pekin were substantial brick buildings of four or five storeys, and were capable of accommodating several hundred men in each. Generally speaking, there is a smaller guard-room situated below, either within the gate enclosure or immediately in front of it, on the inside, where a petty mandarin has charge of a few soldiers, who lounge about the gate, unarmed though in uniform. They take cognizance of the people passing in and out. Their duties are more of the nature of police, and they support themselves to a large extent by their extortions on the poor people bringing their garden or other produce into the city for sale. When visiting the city of Suchow, I noticed that the front face of the wall of the city near the top of it, below the embrasures, was thickly studded with re-curved hooks, standing out about two inches from the surface, and resembling stout nails. They were no doubt intended rather to prevent the garrison escaping than for defence.

The Chinese have some curious superstitions connected with their city walls; for instance, when Brigadier-General Sir C. Stavely broke a way through the city wall of Tien Tsin, the Chinese governor made an urgent request to be allowed to build up the wall, saying, "That the god of destructive fire would be sure to enter the city, and that it would be burnt in consequence." A new gate cannot be opened in a city without the special permission of the Emperor.

On examining the plan of structure of the walls, one might suppose that they would not stand any time when exposed to our breeching ordnance; but experience has shown that they are capable of a good deal of resistance, owing to the mass of clay with which they are backed. Frequent opportunities have been afforded for testing them, in the various expeditions against the rebel Taepings, in which English and French artillery were engaged.

Against the artillery in use in former days these walls could stand without much difficulty. When we examine what these weapons were, we can readily imagine this. On looking over old Chinese books, giving a description of their ancient battles (by which they appear to have been familiar with escalading ladders), the form of the cannon (Fig. 5) appears very different from that of those now in use. It is curious to

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notice that some of the original forms were breech-loaders (Fig. 6). A few of these were found after the capture of Tien Tsin. They were made of wrought iron, though heavy enough to require two or three men to lift one of them. The plan of their construction was so contrived, that the ball could be introduced at the breech, and the charge of powder placed in a movable chamber, made of wrought iron of sufficient strength to withstand the explosive force. This was let into a chamber at the breech behind the ball, and fired through a touch-hole, as in the ordinary way. The rude fitting of the powder chamber, which also closed the breech, showed that there must have been a great waste of powder, although it probably insured rapidity of fire. They were evidently used as swivel guns, and were chiefly intended for on board ship. As this form of breech-loading cannon was known in Europe in the early part of the sixteenth century, it is probable that it was introduced into China by the Portuguese. The form shown in Fig. 5 is probably the most original of all forms of cannon. I observed many of them among old arms in the city of Tinghai, at Chusan. They were about three feet in length, made of wrought iron, and strengthened by rings. Several old cast-iron guns are usually seen on every city wall, resembling the form hitherto familiar in Europe, and they were no doubt derived from European patterns. The date of these guns are always to be seen recorded in raised Chinese characters, made in the casting, showing the year of the reigning Emperor, and the place where they were cast.

Some very fine brass guns, of great length and calibre, were found at the Taku and Tien Tsin forts after their capture, showing great skill in casting such large pieces of ordnance. In the engagements against the rebels, near Shanghai, all descriptions of modern ordnance were used; and the governor of the province, Lee Fu tai, seeing the value of this arm of the service in warfare, has a well-equipped force of modern artillery, officered by Europeans, and maintains a laboratory for manufacturing shot and shell, percussion caps, &c., in which the newest appliances of steam machinery are employed, under the superintendence of Dr. McCartney, formerly an assistant-surgeon in the 99th Regiment. This laboratory was till lately in the city of Suchow, but now occupies some old buildings at Nankin, at the place where formerly stood the famous porcelain tower. Lee Futai gave permission for the materials of this tower to be employed in building the new laboratory.

On the capture of Pekin, several beautiful models of guns mounted on gun-carriages, perfect gems of art, were found in the Summer Palace. Still they never served to induce the Chinese to adapt them to any extent to a practical use. These models were either made from European designs, or may have been sent as presents from European states to the Emperors. A Japanese work on China, shows that the form of the mortar was familiar to them, though none were found in the forts captured by us. Lieutenant Kane, R.A., while instructing the Chinese at Tien Tsin in gunnery, constructed a couple of carriages for field service, and mounted them with brass guns. Chinese ponies were used instead of horses, and they appeared to answer very well, when there were enough of them attached to each gun, and the Chinese

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gunners showed sufficient expertness in going through their exercise; but it is very questionable whether the Chinese Central Government will profit by what they have been taught, or will make an Artillery Branch of the army, like that in the armies of European states. Very few guns mounted as field artillery were met with in the campaign in North China in 1860, and those found were exceedingly rudely mounted.

In a Japanese index of yearly occurrences of note, it is recorded for the year 1860 as follows:—"The Chinese empire transferred to the "Russians 2,700 le, = to 900 miles, on the north side of the Black "Dragon River, in exchange for great guns." It is supposed that some of the guns which fortified the Taku forts were derived from this source.

Du Halde says: "Artillery is but a modern invention among the "Chinese; and though that of gunpowder is very ancient, they have "seldom made use of it but for fireworks, wherein they excel. There "are, however, three or four bombards, short and thick, at the gates "of Nankin, ancient enough to prove that they had some knowledge "of cannon, though they seemed to be ignorant of their use, for they "serve for nothing but to be shown as curiosities. They had also a few "patarreroes on board their vessels, but had not skill enough to make use "of them." "In the year 1621, the city Macao having presented the "Emperor with three cannon, and men to manage them, the first trial "was made before the mandarins, who were greatly surprised at the "novelty, but more when they saw that one of the pieces, in recoiling, "killed a Portuguese and three Chinese, who did not get out of the way "time enough. These guns being employed against the Tartars, who "came in swarms towards the Great Wall, they were so terrified by the "havoc made by them, that they fled, and durst never approach it any "more." He further tells us, that in the year 1636, the Tartars made another eruption against China, and alarmed the Government so much that they requested one of the missionaries of the Jesuits, named P. Adam Schaal, to cast some guns for them, but he transferred the matter to another missionary, named P. Ferdinand Verbiest, who was acquainted with the art of casting metal, and the result was that 130 pieces of cannon were cast. Subsequently he got an order to cast 320 cannon, which he completed in about a year, and so greatly pleased the Emperor, who appears to have taken a great interest in the trial of these guns, that great honour was done him at court, and the missionaries gained much favour and support.

In ordinary times of peace the military occupy the guard rooms over the gates of the cities, and in time of war, they occupy the public buildings to some extent, or the soldiers are encamped along the top of the wall, or in the open unoccupied spaces, always found within the walls. Within the cities there are no regular barrack buildings as with us, the only instances of such that I found in China, were outside the Anting Gate at Pekin, and in the military cantonment of She ling, in the western part of the province of Chili (Figs. 7, 8). These barracks consisted of a series of ranges of one story houses, large enough to accommodate ten persons in each. There was a small enclosure in front of each room. The rooms were, as nearly as I could estimate, 18 feet in width and 21 feet long, and 15 feet high,

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and at the end opposite the door there was a kang or raised platform; on which the men slept as on a guard bed. A flue from a fire-place in front, led in a tortuous manner through the kang to a chimney which opened at the roof, near its lower margin, and not at the apex, as with us. The fire-place was made available for cooking purposes, a cast-iron pan, about 22 inches in diameter being inserted on the top of the fire-place, while the fire was fed through an aperture below. The space between the ranges of buildings was wide enough to permit the men to parade in line, and march through in the formation of four deep. I did not enter the rooms at She ling, but did so at a barrack building near the Anting Gate north of Pekin, which was not enclosed by a high wall as at She ling; in the latter place, at the time of my visit, these rooms were occupied by a number of Tartar women and their children, the families of the soldiers who were absent at Jehol. The entrance doors of other rooms were built up by masonry. The mechanical skill displayed in the wood work, and fittings, could not be surpassed by our workmen, and the masonry was of the best possible description. A large building opposite the south entrance was occupied by the commissioned officers, and the sub-officers occupied the central rooms in the ranges behind. The barracks and passages appeared to be kept perfectly clean. There was not the slightest smell of a disagreeable nature about the place—and a good drain made of cut stone formed a channel for the rainfall from the roofs of the houses, to be carried off. This drain ran along the ground close to the wall, which formed the back of the rooms. There were no windows in this the northern wall, as there never are in houses throughout China. The windows and doors faced the south, and admitted sufficient light to make them cheerful. The ranges being of one story and sufficiently apart from each other, did not interfere with light or ventilation, and they were not exposed to severe blasts in cold weather.

When on the march, a regiment of Chinese soldiers does not entrench itself at every halting place, but when in the vicinity of an enemy they lose no opportunity of doing so, and it is worth recording with what extraordinary rapidity this is done. Immediately on the ground being selected by the commandant, all hands set to work with spades and picks, and make a breastwork and ditch in a few hours, then collecting a quantity of stakes, sharpened to a point at both ends, made from bamboos or stout branches of trees whichever is afforded by the locality in greatest abundance, they plant the ground thickly all round the intrenchment about knee high, for a distance of about 10 yards wide. They also sometimes adopt the plan of felling trees if near them, and covering the ground in front, the stems being towards the stockade—other contrivances are also used, for instance, numerous holes about 2 feet deep and 1½ feet wide are dug close together, and at the bottom of these holes, sharp stakes of bamboo are stuck, so that a bare footed person stepping into one of these holes would be disabled at once, or even a person with shoes would suffer.

The appearance of a Chinese encampment, when seen at a distance, has a remarkably gay effect, owing to the number of gaudy coloured

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banners seen fluttering over it, reminding us somewhat of the passage in Marmion, descriptive of the camp—

> Nor marked they less, where in the air
> A thousand streamers flaunted fair;
> Various in shape, device, and hue,
> Green, sanguine, purple, red, and blue,
> Broad, narrow, swallow-tail'd and square,
> Scroll, pennon, pensil, bandrol, there
> O'er the pavilions flew.

The encampment is composed of a series of entrenchments, each entrenchment being occupied by a separate regiment, distinguished by a flag or banner of an uniform colour and pattern of its own, and distributed in the proportion of one banner to every ten men. The regiments are generally small and number, on an average, about five hundred men each. An entrenchment for a regiment of this strength would occupy ground measuring 100 paces by 50. Its outline is generally a parallelogram in form, and consists of a breastwork, formed by the earth dug out in making the surrounding ditch. This ditch is sufficiently wide and deep to keep the men from breaking out of camp rather than for defence. Near the top of the fence there are apertures by way of embrasures or loop-holes for jingals or matchlocks to be fired through, and generally, at the angles, there are flanking defences. There is but one entrance, which is closed by a folding gate, and barred on the inside (Fig. 9).

The tents, as regards the two central lines, are usually found in regular rows, and about 9 feet equidistant from each other, but in other respects they are placed only as regularly as the formation of the ground and the number of tents occupying it permit. A wide pathway, dividing the centre lines of tents, leads straight from the gate to the tent of the commandant, who is usually a blue-buttoned mandarin, and is subordinate to a higher mandarin, having a red button, and corresponding to a General of Division.

I took the following dimensions of a Chinese tent in an encampment some distance from Shanghai. Its area was 15 feet by 15 feet, it was 7 feet in height, and nominally accommodated ten men with a sub-officer, who was in charge of it, and the men who occupied it. It was made of thick cotton cloth of foreign manufacture, known as American drill, about a yard in width, and where the pieces were joined together a stoutish rope was sewn up with it to keep the strain off the cloth and to add strength to the material; this rope was also connected with one running along the lower margin of the tent and formed the guy rope by which it was fastened to a stake driven into the ground. This material was not very lasting, nor did it give much protection against sun, rain, or cold, so that pieces of older tents had to be thrown over it, consequently the encampment had a very patched dingy appearance. The tent was supported by a horizontal bar of wood, resting on three upright poles of bamboo, having a projecting iron spike which fitted into a corresponding hole in the horizontal bar, and where one of the upright poles was not long enough it was raised by a layer or two of bricks or stones. To make the tent

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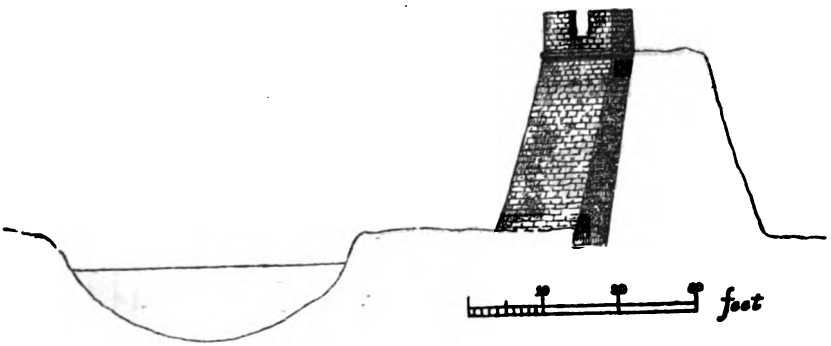
FIG. 1.

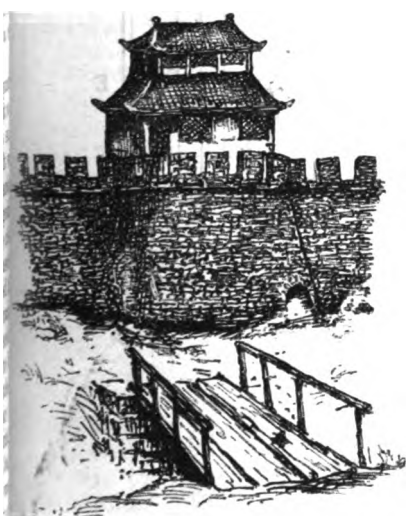
Plan of a City Wall with the Flanking Defences.

FIG. 2.



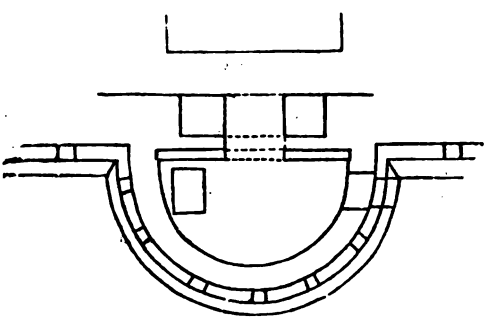
Section through a City Wall and Ditch.

FIG. 3.



West Gate of City of Shanghai.

FIG. 4.



Ground Plan of West Gate of Shanghai.

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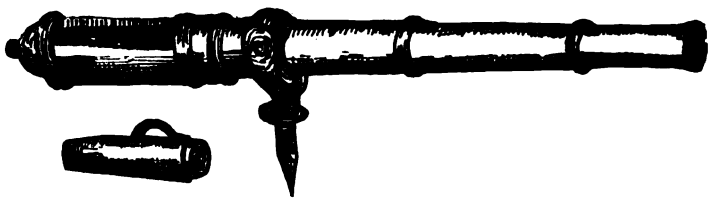
FIG. 5.

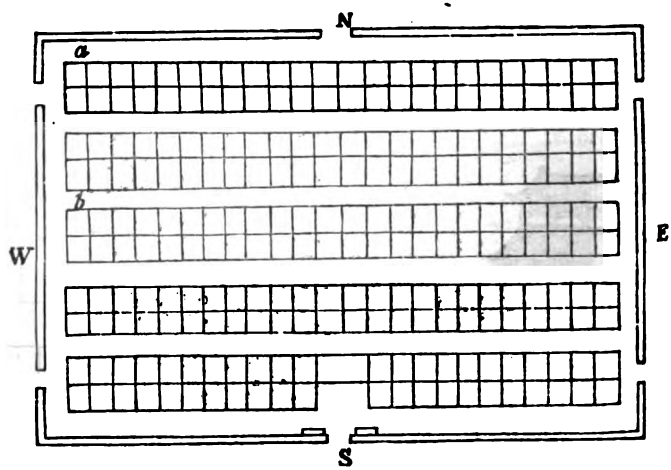
Original Form of Chinese Cannon.

FIG. 6.



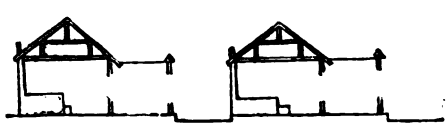
Ancient Chinese Breech-loading Cannon.

FIG. 7.



Ground Plan of Barracks at She-ling.

FIG. 8.



Section through *a b* of Ground Plan of Barracks at She-ling.

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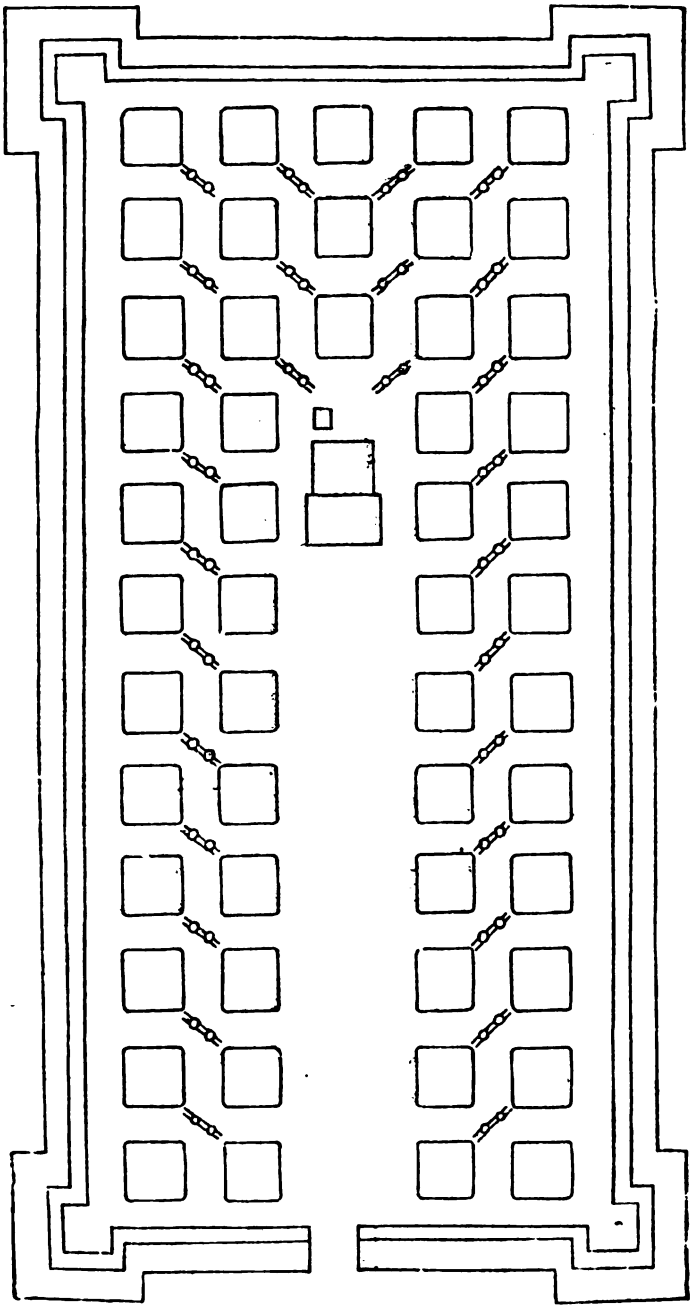
FIG. 9.



Ground Plan of Chinese Camp.

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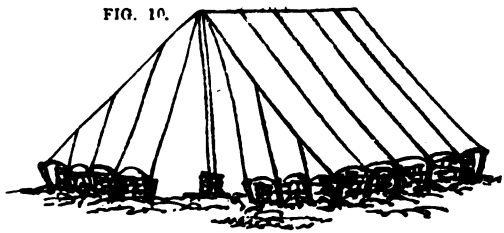
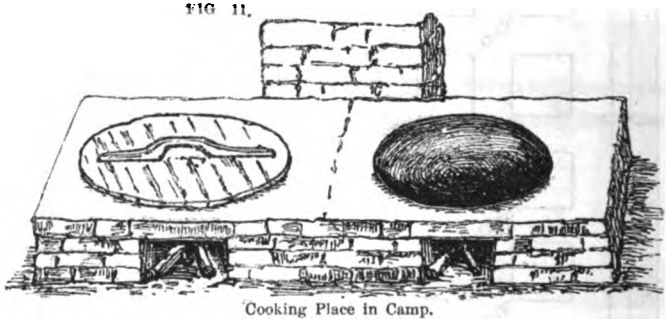
FIG. 10.



Chinese Tent.

FIG. 11.

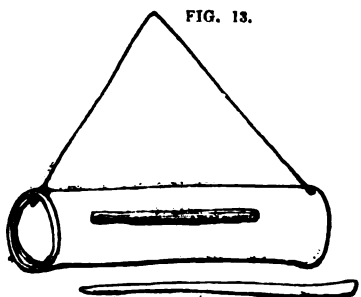


Cooking Place in Camp.

FIG. 12.

Cooking Place in the Field.

FIG. 13.



Watchman's Rattle.

FIG. 14.

Military Hut used at Taku.

FIG. 15.

Chinese Soldier's Turban.

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FIG. 16.

Head of Chinese Soldier after Decapitation.

FIG. 17.

A Chinese Soldier armed with Matchlock.

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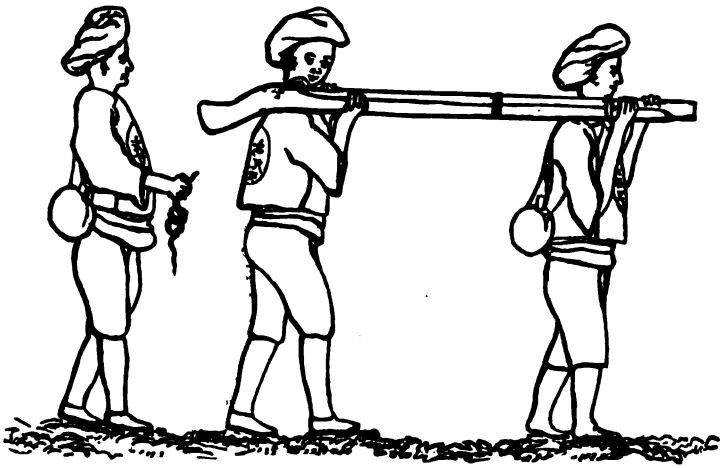
FIG. 18.

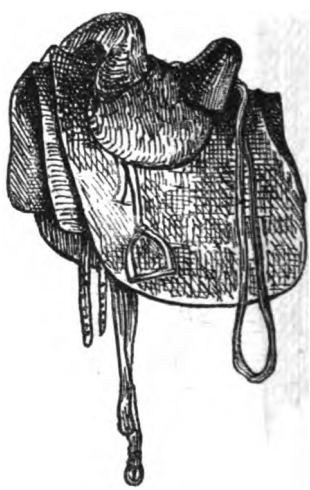


Jingal Men.

FIG. 19.

Chinese Military Band.

FIG. 22.



Chinese Saddle.

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FIG. 20.

Heavy Battle Axe for Exercise.

FIG. 23.

Chinese Bridle.

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FIG. 21.

Tartar Cavalry Soldier.

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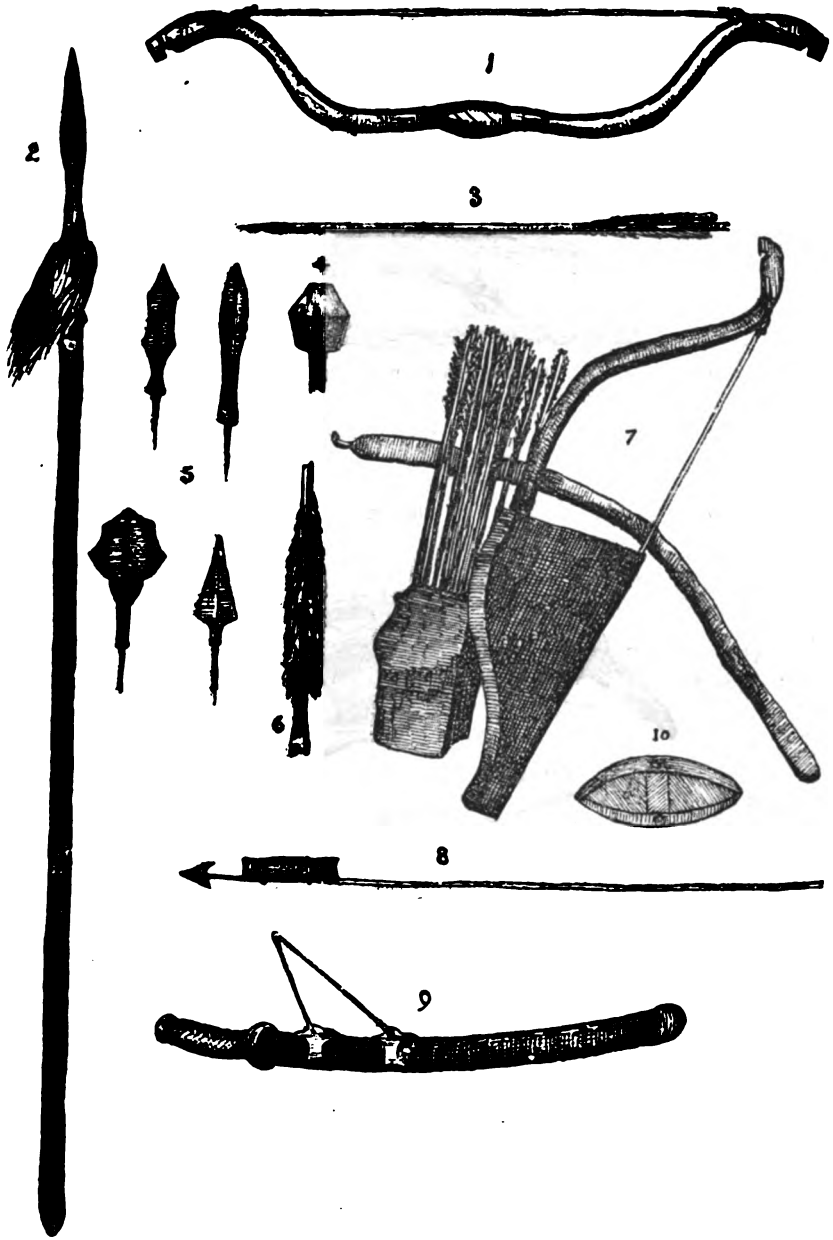
FIG. 24.



Chinese Arms, in the Museum of the Royal United Service Institution.

1, Chinese Bow. 2, Spear. 3, Arrow. 4, Head of Whistling Arrow. 5, Arrow Heads. 6, Feathering of Arrow. 7, Quiver and Bow Case. 8, Arrow Rocket. 9, Sword. 10, Section of Bow: *a*, buffalo horn, *b*, bamboo, *c*, layer of cowhide, fastened together by a very insoluble glue.

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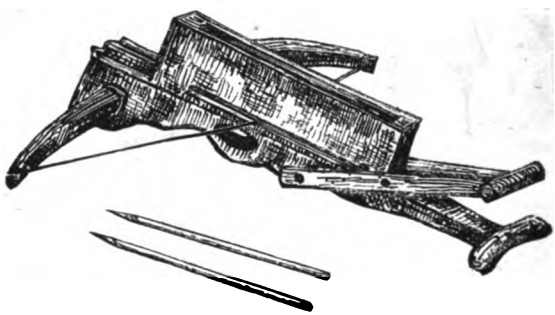
FIG. 25.

Shooting with the Bow on Horseback.

FIG. 26.



Cross Bow.

FIG. 30.

Chinese Short Sword.

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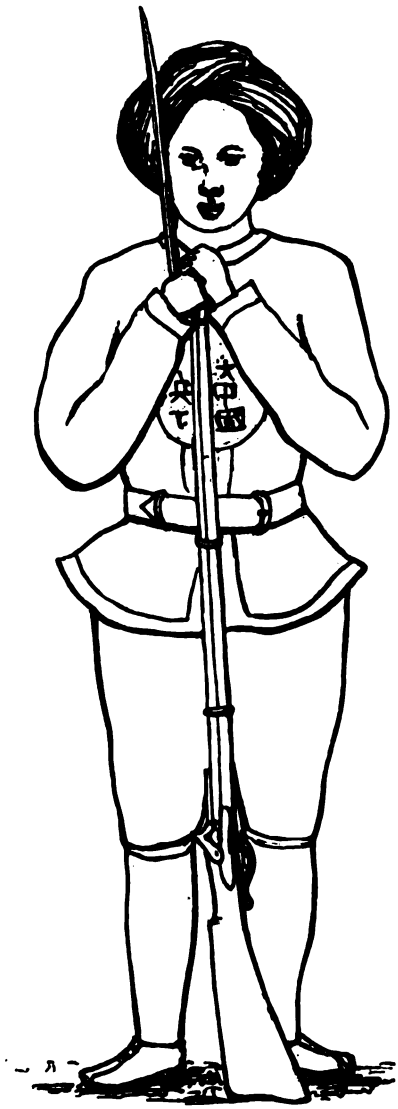
FIG 27.

Imitation Foreign Soldier.

FIG. 28.



Chinese Soldier armed with Minié Rifle.

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FIG. 29.

Costume of Chinese Officer.

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more comfortable and to protect themselves from the wind, the men raised a course or two of bricks 1½ feet high all round, excepting at the entrance (Fig. 10).

The appearance of the interior of one of these tents was as follows:—a number of thickly quilted rezies, corresponding to the number of men who occupied the tent, were spread upon the floor over a layer of straw, or old mats, or reeds, the men slept enveloped in these rezies. Some loose clothes and accoutrements lay in an untidy manner on each bed or rezie. There was a teapot on the floor and a few empty bowls with chopsticks, and a pair of Chinese shoes, put out to dry with their soles uppermost, also some billets of wood used for fuel. The ground was not swept, so that it appeared very untidy and dirty. The arms, smooth-bore percussion muskets of English manufacture, were tied up in a bundle alongside the middle upright pole, with common string. Each tent had its own cooking place, consisting of two cast-iron pans, about 22 inches in diameter, set up on a hearth, built up of bricks and mud (Fig. 11). These cast-iron pans are made in immense quantities in China, being of universal use throughout the country, their price varies from sixpence to a shilling of our money. It was not uncommon to find two sets of these cooking places joined together and a common flue constructed between them, and covered in by old mats spread on a few wattles, or they would be simply placed over a groove, scraped out of the ground, to serve for a hearth (Fig. 12). This is commonly done on the march or in the field. A number of drains were constructed through the tents to carry off the rain to two larger drains, one of which ran along each side of the centre pathway to the ditch outside; these drains were half filled with filthy water, and no doubt made the entrenchment in a bad sanitary condition. The latrine arrangement was also very defective, it was placed in a projection from one of the sides of the entrenchment, another had it at one of the angles, and were it not that the accumulation was frequently removed by the local farmers, for agricultural purposes, its condition also would have been very bad. In the camp near the south gate of the city of Shanghai from which the ground plan of an entrenchment (Fig. 9), was taken, there was no latrine arrangement whatever, consequently the immediate vicinity, although surrounding the residence of the Fu-Tai, the chief magistrate of the province, was in a horribly filthy state. In this entrenchment, being liable to be attacked by the Taeping rebels, the angles were so constructed as to form flanking defences; a pathway extended all round the inside of the entrenchment, where the men on guard during the night made their circuit, at the same time beating a hollow cylinder made of the joint of a large sized bamboo having a long slit on one side, so as to increase the sound when struck by a short stick (Fig. 13); it was worn suspended from the neck by a string, and at certain periods of the watch was made to resound through the camp in monotonous time. If struck slowly it signified that "all was well," but if it was struck rapidly it implied an alarm, and by modulating the sounds one watchman could make intelligible signs to another, while a considerable distance apart.

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In nearly all the fortified places captured in the north of China in 1860, a curious mode of hutment (Fig. 14) was noticed of rather a novel and ingenious kind. These huts were very numerous in Tung Koo, and were found in the Taku Forts to be the only barrack accommodation for the garrison. The mode of their construction was very simple. A framework of wood of sufficient height (8 feet) and stoutness, supported two horizontal pieces of timber corresponding in length to that of the structure, about 20 feet, over these were placed, so as to form the sides and arched roof, a series of long bundles of the reed *Arundo Sinensis*, found growing so universally in China. These reeds are about half an inch thick at the base, they are about 8 or 9 feet in length, and though hollow, are very strong and cane-like. Each bundle was about 5 inches in width, and tied together by some common jute fibre growing in the country, and joined together so as to be made sufficiently long to reach from the ground on one side, to be carried over the platform or frame work to, and reach the ground on the other side, both extremities being buried in the earth. Next to this a similar bundle was laid, and joined so as to prevent displacement by numerous stakes of wood run through to serve as pins, till the whole structure was completely covered as to its sides and roof. It was then plastered with wet clay, and the ends were closed by a kind of wattle and dab partition, leaving a space for a door and window at one end and a window in the opposite end to serve for ventilation in the very hot weather. Each hut could allow of twenty men sleeping inside, being about 12 feet wide. These huts were arranged in regular rows side by side, with a narrow space between them, most of them were without kangs, as they were not intended to be occupied during the winter season, when the ice was a sufficient protection to the place. They were in a measure suitable to the climate, as they afforded good protection against the sun, and the little rain which falls in the year, could not do much damage to them. They could be constructed with great expedition, and the materials were abundant, while timber and deal boarding was exceedingly expensive if not unprocurable.

By a fundamental law of the Chinese Empire every man is liable to serve the State, either as a soldier or as a labourer in the public works of the country, such as canal-making, &c. There are, however, exemptions to this law. For instance, those who have taken certain literary degrees, or who are already in public employ; and it is in the power of all to exonerate themselves by paying what is called an exemption tax, which is one of the most considerable sources of revenue the Government have. There is never any necessity for claiming an individual on the plea of this law, as the labouring class of the population is so numerous that there is no difficulty in getting men to recruit voluntarily. A notice posted up at the gates of the city stating that men are wanted, is sufficient to procure any number of recruits from the labouring or coolie class, especially if the necessity which requires an increase of the army be the occasion of interfering with the means of livelihood of such persons. Chinamen being in the habit of associating in large numbers in the tea houses of the towns and cities, where they discuss the events of the period over a cup of tea instead of a pint of beer or

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a glass of grog, calculate their chances of loot and the circumstances of the service for which men are required, and if they see that they have a favourable prospect open to them in the army in the way of punctuality in their pay and subsistence, and a chance of employment failing them in civil life, they enrol themselves in a corps, by entering their names, age, place of birth, in the roll of the corps they enlist in, and receive in return a small tablet of wood, called a *you pai*, about half an inch thick, three inches wide, and four inches long, on which the name, age, place of birth, corps to which belonging, and the date of enlistment are written. Recruits have to undergo no medical examination to ascertain their fitness or otherwise, and are approved of by their general appearance, just as we should select a coolie out of the streets if we wanted to employ one. They know what is required of them, and that if they are not capable of performing their work through physical disability, they will be simply dismissed.

In time of peace there can be no difficulty in getting men to fill up a vacancy in a city guard, or in the limited ranks kept on service, though the wretched appearance of such soldiers must, one would think, make employment at any other pursuit far more preferable. The opportunities for peculation and extortion on people of the lowest class of the population are the great motives for entering the service, whether to be employed at the gates of the cities or at the numerous barriers posted all over the country on the roads or canals, for the purpose of collecting revenue or tolls, at places which require a small guard of soldiers to enforce the orders of the mandarins.

Du Halde says: "As the military business does not take up much "of their time in a country which has been so many years at peace, "far from being obliged to enlist men by force or money, as is prac- "tised in Europe, the profession of a soldier is commonly looked upon as "a fortune, which they endeavour to procure by means of their friends, "or by presents to the mandarins, the service being generally in the "country where they dwell and have their family."

Men who have committed civil offences, such as that of forgery, are sent to the remote frontiers to form the guards there located. The provincial armies are maintained and equipped by subordinate mandarins, Taou-Tais, or governors of districts, each district having a certain proportion allotted to it. Some corps supported by the district governors may consist of strangers to the province, and it is only under great emergency that corps forming part of an army of one province can enter another. The Commandants and Generals of divisions are all appointed by the Governor-General, and great care and judgment are required in making these appointments, one principle being observed, that each Commander be sufficiently antagonistic to another in interests, by rivalry, or petty jealousies, so that there need be no apprehension of their acting seditiously in concert with each other. For the same reason large bodies of men are kept apart as much as possible, for fear that if they raised a general mutiny there would be no means of suppressing it; but mutinies are not unfrequent, owing to mandarin dishonesty, involving arrears of pay, and of supplies for the subsistence of the men.

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In the vicinity of Pekin, large bodies of Manchu and Mongol troops are maintained for the immediate defence of the Emperor. At Canton, a quarter of the city within the walls was garrisoned by the descendants of Tartar troops, who were stationed there as a garrison to keep in check the local military; and at Nankin there was a similar military colony established, till the capture of the city, when they were annihilated by the Taiping rebels.

The pay of a coolie or labourer is about two hundred and fifty or sixty cash per diem, which, at the exchange of one thousand cash for a dollar, is equal to twelve pence halfpenny or thirteen pence of our money. The pay of coolies employed by our Government in China is eight dollars a month; and a soldier in those corps which were raised for instruction in drill, got eight dollars a month and clothing. Those belonging to corps of local militia at the camp of instruction, got similar pay to men serving in their army in general, which was five dollars a month, an allowance of rice and fuel, and two suits of clothing a year, consisting of turban, jacket, and trowsers. They were to provide their own necessaries—boots, socks, bedding, cooking utensils, &c.

Du Halde says: "The three northern provinces furnish abundance "of soldiers, who, every month, receive their pay, being five sous of "fine silver, and a measure (1¼ lb.) of rice per diem, which is suffi- "cient to maintain a man. Some have double pay, and horsemen have "five sous more, with two measures of small beans to feed their horses, "which also are provided by the Emperor."

In the matter of paying the troops there is a vast amount of squeezing. The Commandant has the payment of his own men, and superintends this, while his writer, who keeps the account, checks the roll, tries by every device to make a profit on the transaction in his own favour, there being every facility for doing so, especially by giving inferior cash, &c. While passing through the barrack at She ling, in North China, I noticed some soldiers drawing their pay from the paymaster's office, which was situated in a small building near the south entrance, in front of the Commandant's house. A window of the office opened into the enclosure, and as each man came up he presented his *you pai*, or tablet, and on referring to the register where his name was entered, the amount was paid to him, and he walked off.

The proverbial squeezing propensities of the mandarins caused Brigadier-General Sir C. Stavely, K.C.B., to make a stipulation with the Chinese Government when requesting that their soldiers might be drilled according to our method, by English Officers, that the Officer in charge of each corps should see his men paid regularly. While this stipulation was very necessary to prevent desertion, it was also most advantageous to us in gaining the confidence of the men.

The food of the labouring class of the Chinese varies somewhat in the different provinces. The scarceness of rice in the further north makes it too dear for any but the richer classes to use it as a common ingredient of their food, and instead of it, wheaten flour and its preparations are made a substitute. Its place is also supplied to a great

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extent by a preparation made from the bean of a species of *dolichos*, called bean curd, or tow foo, resembling cream cheese in consistence, and no doubt containing a great deal of concentrated nutriment, but it is quite unsuited to our stomachs. This condiment is also used to some extent in the central provinces; arrowroot, made from the roots of the nelumbium, and yams are also used largely as food. The more northern people use much more animal food, such as beef and mutton, than they do in the south, and do not disdain horse or camel flesh, and all use either sea or fresh water fish, recently caught or dried, whenever they have the opportunity of obtaining a supply. Of the numerous varieties of vegetables grown in the country, a species of borassus, or cabbage, called by us white cabbage, is universally used. The more southern people use very little animal meat, which generally consists of pork, some oleaginous matter being an essential ingredient in rice food. The labourers' food consists of rice, cabbage, salt fish, and oil or pork fat, and will cost as follows :—

Rice, 1lb.	50 cash	1000 = 1 dollar.
Cabbage, 1½ lb.	45 „	
Salt fish, ½ lb.	15 „	
Pork fat or oil, ⅛ lb.	10 „	
	120	

If he procures his meals in a cooking shop, he will pay as follows :—

Breakfast ..	1 bowl of rice..	16 cash.
	1 bowl of cabbage and oil	14 „
Mid-day meal	2 bowls of rice	32 „
	1 bowl of cabbage and oil	14 „
Evening meal	1 bowl rice	16 „
	1 bowl cabbage and oil	14 „
		106

A measure of rice, equal 1⅓ lb., is the quantity allowed as a day's ration per man, to soldiers.

The large body of Chinese coolies employed by the expeditionary army were allowed 2 lbs. of rice per man per diem, during the time they were employed, and Colonel Gordon's force of Chinese were allowed the following scale per man per diem :—Rice, 2 lbs.; salt pork, ¾ lb., or 2 lb. of salt fish, besides vegetables and oil. (See Blackwood, Feb., 1867.) The hard labour scale fixed by the joint foreign and Chinese Commissions at Shanghai, allowed the prisoners the following scale :—"Prisoners shall be allowed three meals a day—

Morning, 4 taels of rice, 1 tael of vegetables.
Noon, 8 taels of rice, 2 taels „
Evening, 4 taels of rice, I tael „

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or about 1¼ lb. of solid food per diem, 2 taels of fish or meat being added every second day."

Rice varies considerably in quality. That which is grown in China, owing to its careful cultivation, has considerably greater nutritive and hunger-satisfying properties than the rice imported from the Straits, or other countries; the latter is so poor (although as fine a looking grain), that three bowls of it barely satisfy a man's appetite in the same manner that one bowl of native-grown rice would do.

The Japanese have a still more nutritious rice than the Chinese, who say they do not like it, owing to its extreme richness. It is strange that rice is not liked by the European soldier, who fancies it produces worms, and Europeans in general in China use very little of it, and that only in curries or rice puddings in a small degree. Rice and more solid animal food are apparently incompatible. It is eaten with carried meats, apparently to moderate the pungent properties of the spices used in their preparation.

In the further north they substitute for rice a preparation of wheat flour, called pie-mien. It is made by kneading dough for a long time, till it acquires a considerable tenacity, and then drawing it out into thin shreds; and by cutting it into thin slices while rolled up into cylinders, after it is pressed into a thin layer. These slices are then drawn out to any amount of fineness. Every separate operation in this process requires great expertness in the cook. These vermicelli-like shreds are cut into short bits about half an inch in length, cooked with oil and hot water, and eaten with the assistance of chopsticks. Bread made of wheat flour is very commonly used; it is unleavened, and the cakes resemble the chopatties of India. It is not met with where rice is the common food of the people.

The Chinese are proverbial for eating as often as they can, and as much as their means will allow them; but the Chinese soldier, when campaigning, limits himself to two meals a day, one at 8 o'clock, A.M., and the other at 4 o'clock, P.M., and this is submitted to mainly from the fact of his supply of fuel being in as limited a scale as his food. Eating houses and tea shops are found in every town and village in the country, and the soldiers when quartered near such places, always make use of them to procure their food, when they do not draw rations.

Fuel (which is of equal importance to an army in the field as food) is often very difficult to be obtained, there being little or no timber. Wood cut up into billets is the most portable form of fuel, and easiest issued, and saves the country people from being pillaged, or even their houses pulled down, to get at the rafters and beams, which I have seen done when campaigning in China. A ration of fuel is very wisely included along with the ration of rice. The fuel is always kept in the men's tents for security. The daily allowance is about 3 lb. of wood per man.

The clothing of a Chinaman varies with the season of the year, and with the latitude in which he lives. The winter of the further north being extremely cold, he is obliged to wear fur coats and sheepskins, to keep his body warm; and the summer being excessively hot, he

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is often in a state of semi-nudity. In the more central parts, the extremes of climate being less marked, furs are dispensed with, and clothing is worn all the summer. The further south being of a more equable temperature, a more equable mode of clothing is there used, or rather less warm clothing is required in winter.

There is one characteristic of a Chinese with regard to his clothing, that is, that he is continually adapting it to every change of weather, and that even in the course of a day, he will vary the amount of clothing with every change of temperature that may occur. The loose make of his dress permits him to do this with much facility, by putting on additional jackets, or by taking them off. Five consecutive jackets, overlaying each other, have been often seen on a Chinaman. The dress of a Chinaman of the labouring class is mostly made of cotton, and restricted to a peculiar cut, imposed by state laws as a badge of his submission to Tartar rule. If it is for wear during the hot weather, it is made of a single layer of cotton cloth; if for colder weather, the coat or the trousers are made of a double layer, and padded with cotton. The clothes worn by civilians, are still retained while they serve as soldiers: a loose jacket of a peculiar form and colour, and having a large circular patch of about 10 inches in diameter in the front of the breast, on which the name of the corps is written in large Chinese characters, constitutes the uniform of Chinese soldiers of the old school. Some of the Tartar cavalry soldiers, against whom we fought in North China, had a jacket of very poor cotton cloth of a yellow colour, on which was written, on a space covering the breast and back, in very rough character, with a common brush dipped in Indian ink, the name of the corps to which the man belonged, and this jacket was worn over the ordinary labourer's clothes, and constituted his uniform.

The military jacket of the troops composing the army of Lee Futai, the governor of the province of Kiang-soo, was made of camlet, of a dark purple colour, and having a margin corresponding to facings, of yellow, about two inches wide round the cuffs, collar, lower margin of skirt, and at the union of the lapels. The trousers were made of common black cotton cloth, commonly worn by labourers, but of a uniform pattern and loose make.

Other troops, instead of camlet, had their jackets made of cotton cloth, dyed of different, but for the most part of dark, colours. On those jackets there was no collar; the edge of the jacket came close to the neck, but did not choke it. It hung loosely over the upper part of the body, and reached a little below the waist. The sleeves were loose all the way to the wrist, and were broad enough to allow the hands of the opposite sides to pass freely up them. The turban was exclusively used by the troops serving against the Taeping rebels. This form of head-dress suits the Chinese head remarkably well: blue, red, and black being the colours most generally used (Fig. 15). In the further north of China the soldiers wore a stiff hat of a peculiar shape. The part covering the head was round, and fitted it closely; the margin or brim was turned up all round; in width it was about three or four inches. The common Chinese felt hat, of a soft pliant texture, and black in colour, was frequently worn by the levies, especially by the horsemen.

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High cloth boots are in common wear, and more generally shoes made of cotton cloth, and the soles of felt, or sandals of plaited straw were worn, but frequently the men went bare-footed, their legs being protected by long loose stockings or leggings, or if bare-footed, with bandages of common black cloth round their shins from below the knees to the ankles. This form of gaiter was very applicable to the country. A commandant of a corps who were thus equipped, on being asked where were the shoes and stockings of his men, replied that in going through paddy-fields, shoes were useless. The men made better way with bare feet; and in going along the narrow pathways, projecting brambles, or the sharp edge of the grass itself, were prevented doing any injury to the shins, a very vulnerable part of a man's body, by the bandages he wore as greaves.

Common China cloth shoes were usually worn, and when wet weather prevailed, leather varnished boots, with projecting nails to prevent slipping in the mud, were very frequently seen. It is curious how well a Chinese soldier adapts his clothes to every circumstance of climate or weather, apparently without general, divisional, or regimental orders to do so. Nor is he prevented using an umbrella if the weather be wet, or hot enough to require it. It may also form a part of his necessaries, as much as his mud-boots, or his fan.

A commissariat department, in the sense we mean, does not exist in the Chinese army. The district governors being responsible for the equipment and maintenance of a certain number of men, supply all their wants through the commandants of corps, who keeps account by his writer, and draws on the local governor for supplies, and sees them issued. The governor obtains these supplies from men engaged in that particular branch of business, and has them delivered at the camp by agreement or otherwise, as he sees it most advantageous to him. The law of agreement or contract is recognised by the Chinese, who are sufficiently business-like in their habits to be punctual in fulfilling the terms of an agreement.

Colonel Gordon organized a commissariat department in his force, composed of European officers, whose integrity could be more depended on than that of the Chinese. There was a mandarin of high rank attached to his force, who nominally had a joint command. A requisition on this mandarin, who served in some degree in the capacity of political agent, also procured food, fuel, clothing, or war material from the Taou Tai, or governor of the district.

Human life being generally esteemed of little value by the Chinese, and a soldier's least of all, on account, perhaps, of the superabundance of the population, and the general struggle for existence, it need not surprise us if the science of surgery and medicine are at a low ebb, and that there is no such thing as a medical department in their army When a soldier gets ill he seeks for a native doctor in the nearest village, after his comrades have expended all their medical skill upon him; and if he gets no better, or if he is unable to perform his duty, he is dismissed from his corps, and allowed to go home, to get well or die, as it may be. If he is engaged on active service, and is wounded, he does not long remain an incumbrance to the State, as he also is per-

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mitted to go home, or to seek whatever native surgery can do for him at his own expense. For sick or wounded there is no hospital, and there are no army surgeons; and were there any, what helpless creatures they would be without medicine or appliances! I recollect visiting a large camp situated not far from Shanghai, at a time when cholera was epidemic in the locality, to see what was being done for the poor creatures, and on passing by an empty house, having neither windows nor doors, I saw a number of the men from the adjacent entrenchments lying on the ground on straw, with their own scanty clothing upon them. Some of them were without even a bowl of water to quench their insatiable thirst. They were simply brought there out of their tents by their comrades, who were only too anxious to get rid of the nuisance of having such sick people near them. Several of them were already dead; and as I passed by, a Chinaman, well dressed in the costume of the better classes, having a fan in his hand, and his nose stuffed with an aromatic smelling leaf, was looking in through the open window. I learned that he was a native doctor who was appointed by the Taou Tai to look after the cholera cases in the camp, and he did look after them in the way I describe, and counted them when they were dead. But even had he had all the medicine at our disposal, he could have done nothing without a proper building and hospital organization; all which would cost too much money. According to their notions, it was far more economical to let the men die, and get new ones in their stead; hence they have no army medical department or army hospital.

On another occasion I was requested by Captain Kingsley to see some of the Chinese soldiers who were under his command, while being instructed in foreign drill. Contrary to the advice of the Commanding Officer, his corps was sent along with a large force of Imperial troops on an expedition against the Taeping rebels, in a position not many miles from Shanghai, with the idea that being in a semi-European uniform, and able to march and manœuvre like a European regiment, their appearance would be enough to frighten the rebels, who had a great terror of foreign soldiers, and thus they might favour the attack of the Imperialists. Unfortunately, they were marched to a very exposed position in the front, and being a raw levy of young recruits, and without their drills to guide or lead their movements, they suffered severely, and lost several men killed and wounded. It was some of the latter I was requested to see; and on going to the boat in which they were brought back to Shanghai I never witnessed a more horrible sight. There were nine bodies literally floating about in their own blood. When they were put on board, the men were alive, but having had no attention paid to their wounds, they had bled to death. Four of the original number who embarked, survived, and I extracted bullets and dressed their wounds, much to their satisfaction. Chinese are very expert in contriving litters for carrying wounded men. On one occasion I met two men carrying another in a large basket suspended from a bamboo by a rope, and on another occasion the wounded man was carried on a door, suspended in a similar manner.

I cannot ascertain whether the Government allows any compensation

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for wounds or loss of limb occasioned by active service, but should rather think not practically, at all events, if they do so theoretically. As the wretched dishonesty of the mandarins would make any scale of pay a nullity, and the wounded soldiers in the north of China, whom I had under treatment in hospital, had nothing allowed to them, they only looked forward to return to their villages, when they would receive support from their friends and relatives.

Colonel Gordon, while in command of disciplined Chinese troops, insisted on a medical staff and establishment being made a part of the organization of his force; and during the time it was in existence, a period of thirteen months, it proved highly useful, as shown in the report of the medical officer in charge of it, Assistant-Surgeon Moffitt, of the 67th Regiment, and no doubt many poor creatures who would have died from their wounds on the field, or afterwards lingered in wretchedness, were either returned to the force as efficient soldiers, or recovered sufficiently well from the immediate effects of their wounds to return to their homes or friends, so that on grounds of humanity alone the intention was praiseworthy.

Chinese soldiers appear to be very amenable to military discipline; whether this is owing to the severe penalties inflicted for any infringement of military law, or to a naturally submissive disposition, it is difficult to say, though probably both have much to do with it. The severity of the punishments may be necessary on account of his psychological characteristics, which will be alluded to presently. Decapitation is of very frequent occurrence in the Chinese army. The offences which entail this punishment are violence or gross disrespect to a military mandarin, robbery, desertion, and crimes of that class. After decapitation, the head is exposed in some public place. While with a small British force occupying the city of Taitsan, as a moral support to the Imperialists, then engaged at the seige of Suchow, in October, 1864, I was passing through the narrow main street one afternoon, when my attention was drawn by a crowd of people looking at what proved to be the head of a Chinese soldier, who had just suffered decapitation. The head was fastened to a doorpost of a shop in the main street, at the corner of a by-street, in the manner shown in the illustration (Fig. 16), and was placed no higher than the level of the heads of the people walking by. The long tail of hair worn by all Chinamen was used as a rope to fasten the head to a nail driven into the wooden doorpost, and, at the same time, served to fasten up a board having a piece of paper spread on it with Chinese writing, setting forth the name of the man, his place of abode, and the nature of the crime he committed—in this instance, highway robbery. While looking at this head I was much struck by observing the quantity of saliva that continued to flow from the mouth, and on examining the appearance of the wound, a very jagged one—indicating that it was not done by one clean cut—I observed that there was a remarkable spasmodic action of the incised muscles of the back of the pharynx and tongue, and continuing to notice this for a little time, I found that the action of the contraction and relaxation occurred at irregular intervals, and that all the muscles appeared to act together. That this was or was not an

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evidence of consciousness or of thought passing in the mind of the individual, may be a difficult problem to solve, but be this as it may, I could not help recording the exclamation of one of our soldiers, an Irishman of course, who was standing by, and observed me watching the muscular movements, which he also noticed. "Arrah Sure I Sir," said he, "I think he is striving to spake." On completing the sketch—it occupied in all about ten minutes—I noticed that the muscular movements continued to be nearly as active as at first, and as the evening was warm, it was not improbable, that they continued for some time longer.

This exhibition of the head was intended as a warning to the Chinese soldiers as much as to the people of the place, most of whom, owing to the country being in a very disturbed state, and but lately subject to the Taepings, were in great wretchedness and destitution, and were only too ready to commit robbery for their maintenance. Such exhibitions are of very frequent occurrence in China, and have a most demoralizing effect, inasmuch as they familiarize the mind with cruelty, and excite feelings the reverse of respect for the sacredness of human life, happily pervading the people of the more civilized west.

The Chinese soldier, like the generality of his countrymen, is by no means addicted to intemperance, the bane of the British army. Seldom indeed is it that a drunken Chinaman is met with, although they do not eschew alcoholic drink as if they were teetotallers, on the contrary they generally take a small quantity at their meals when they can afford it. But what alcohol is to the British soldier, opium is to the Chinese soldier, and it gives almost as much trouble to their military commanders, and requires the infliction of severe punishment for its restraint, as intemperance does to our own commanding officers. The punishment usually practised by the Chinese for this offence, is to stick small arrows, a few inches in length through the lobes of the ears, and to lead the culprit about the camp for a general admonition. But we can understand how ineffectual punishment is, when we know that the desire of the opium smoker for opium, "is like the greed of the hawk for flesh," as the Chinese describe that peculiar craving of the *habitué*. Opium has the effect of injuring the health and sapping the strength of those who addict themselves to it. They have a stupid look, have no energy, and when required for duty or parade, they are likely to be labouring under its sedative effects, and sleep so soundly as not to be easily awoke; it does not make them riotous however, or violent, as alcohol does.

For such offences as breaking out of camp, talking in the ranks, negligence in performing drill, and other offences of a minor character, the punishment inflicted consists of so many blows of a bamboo, varying from 50 to 200, according to the gravity of the offence. This punishment is inflicted by men set apart for this especial duty. There are two or three in every camp, and it is their business to be present at all parades, in case their services should be required, which is very often the case. They are called the bamboo men, and the bamboo they inflict the punishment with, is about 4 feet in length, and broad and flat at the extremity which inflicts the blow; it is about 2⅔ lbs. in weight.

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The man who is to be punished lets down his trousers, and lies on the ground, face downwards, so as to expose the back part of the thighs, on which the blows, given with considerable rapidity, are inflicted. A man assists in holding down the head and shoulders of the culprit during the operation, and another holds or sits on his legs if he is not sufficiently submissive. This punishment may be made very severe, and produce a considerable amount of abrasion of the integuments, and bleeding; and even in ordinary cases, it causes some amount of pain, as evidenced by the shrieks of the sufferer.

These punishments are inflicted in a very summary manner, by the order of the officer commanding, in the presence of the parade where the offence has just been committed. There are no courts-martial, long legal investigations, or courts of inquiry, nor is the approval of the highest military authority in the command at all necessary. The military commandant of the garrison (if of sufficient rank to be invested with the power of life and death) orders the infliction of capital punishment as soon as he is satisfied with the guilt of the individual, from the written statement of the evidence, or even without this formality in war time. As an instance of the irresponsible power exercised by the commandants of regiments, I may narrate an occurrence which took place at the Camp of Instruction at Foug'-wan-shan. While Major Jebb was paying a visit to one of the commandants, by name Yuen, one of his men was brought before him on a charge of desertion; the commandant who appeared to be in a great rage, ordered the deserter's head to be cut off, when Major Jebb entreated the mandarin not to have it done. After a little demur, the latter acceded to Major Jebb's request, but before it was noticed what he was going to do, the mandarin took out of his pocket a penknife, which Major Jebb had just made a present to him, and opening the blade cut off the deserter's ear, and told him to be gone.

A Chinese regiment on the march is a very curious sight, and provokes much ridicule in any one who has been accustomed to see a European regiment under similar circumstances. The men observe no order, unless that of walking one after the other may be called marching in single file, and this they are in the habit of doing on the narrow pathways, through their paddy fields and extremely narrow roads, and over the peculiar bridges found in all the provinces of China, except those in the further north. The men are only recognised to be soldiers by a white patch, on their dingy looking jackets; in other respects they might be mistaken for a number of coolie labourers, carrying bundles of odds and ends. No two of them are equipped alike; for instance one carries his matchlock over his shoulder, and has suspended from it at one end his bedding, in the form of his rezie rolled up, and from the other a pair of heavy boots, to be worn in wet weather, and in addition to these, a bundle of cloths, fastened together by his turban, he himself walking bareheaded and barefooted. Behind him follows a coolie-looking fellow, carrying a couple of cooking pots, and a bag, perhaps of rice, or some other bundle of impedimenta. Then come a couple of banner men, using their long bamboos, to carry some bundle or other suspended between them, it may be a tent. Altogether it seems

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the least military looking procession one can well imagine. Most of them carry umbrellas, fastened to their backs if the weather is dry, or in hand and open if wet. This is the case with Chinese troops of the old school, when marching from camp to camp. With those who have been drilled after the European method it is different, the heavier musket or rifle and ammunition are quite enough burden for a man to carry, without encumbering himself with other things, and unless it be a blanket worn horse-collar fashion over his shoulder, he has no other encumbrances. They take a pride in marching in some order resembling a European corps, whenever the width of the road permits them to observe some formation, such as two or four deep.

The transport employed in the movement of troops, varies with the locality where operations are carried on. Where there is water communication—generally the case in the central and southern provinces—the boats of the country are employed for transporting material, and the Chinese being admirable boatmen, their movements are carried on with considerable expedition. Steamers of very light draught have been employed on recent occasions in the service of the Imperial Government, but there is often such an accumulation of water plants in the canals and creeks, that their movements, especially if they are screw steamers, are frequently impeded. In the further north, where the country is open and when the rivers are few as compared with those in the more southern parts, carts, very much resembling those used in some parts of Europe, are frequently met with; the animals employed in draft being either oxen, ponies, or mules. Each cart will carry about ten men with their baggage, consisting of bedding, cooking utensils, and arms; their progress is at the rate of about fifteen miles a-day over good roads. Where neither carts nor boats are available, coolies are employed; two will carry about 1 cwt. suspended between them in their own fashion, from an elastic bamboo pole resting on their shoulders.

When marching out to action it is pretty much the same as when on parade for exercise; all are then equipped in regular order, their arms ready for use, and their banners unfurled, and as there is a banner in the proportion of one to every 10 men, there are a great many to be seen with a large body of troops. These banners have a very gay and even gaudy appearance, being made of silk died of bright colours; some are very large, being 6 to 8 feet wide, and about 12 feet long. The margin is sometimes serrated in a peculiar shape, after the conventional mode of delineating flame, and at others it is plain and straight. They usually have some motto, inscribed in large characters upon them, and each corps has a uniform pattern. They are suspended from a straight bamboo pole, about 13 feet long, tapering to a point, which is terminated by an iron spike, and intended for use as an offensive weapon as occasion may require, and one of the exercises they go through on parade is thrusting with this banner pole. This requires a good deal of strength and expertness, and certainly in their hands it has all the appearance of being a very formidable weapon. They would be very formidable for cavalry to encounter, the bright colours of the flag being quite sufficient to turn any horse. Their

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principle object is to make display, and inspire terror into their enemy by showing how numerous they are, and to give confidence to their own men. The modern disciplined Chinese troops have done away with these banners in their corps, though the divisional commanders retain a number about their persons for state display.

With infantry the matchlock is the common arm in use (Fig. 17). It is a very rude and primitive weapon, and very inefficient unless at very close quarters, the bullet being not much larger than a good sized slug, weighing about one drachm and a half. These bullets appear to have had very little penetrating force:—in most instances of wounds caused by them, during the attack on the Taku Forts, they did not penetrate beyond the integuments. I removed one from the lobe of the ear, another from the lip, and many of the men found them in the folds of their great coats, which they wore horse-collar fashion during the action. The length of the barrel is about 38 inches, and the stock is short at the breech, having nothing to rest it with against the shoulder. It is held in the right hand close to the cheek when being fired, the left hand supporting it further up the barrel. There is no trigger guard, and the match holder is made to move by a lever arrangement in the wood-work of the stock near the breech. The matchlock is loaded with loose powder, kept in a powder-horn, the proper quantity being guessed by first pouring the powder into the hand. The bullet is put into the mouth and wet with saliva, is simply dropped into the barrel. The moisture on the bullet makes the powder adhere to it, keeps it in its place, and makes it fit the barrel closely. After this has been done, a finer grained powder is poured from a second powder horn into the priming chamber close to the touch hole. Then the lighted match is applied to the match-holder. Notwithstanding the apparent clumsiness of the mechanism, all this is done with wonderful celerity and expertness, from long-continued practice; and on seeing the Chinese soldiers at ball practice, they appear to have as elaborate a formality in their position drill as we have in our rifle practice.

A regiment at ball practice parades in line about one hundred paces from the target, and each man in turn steps a couple of paces to the front, goes through the process of loading, priming, fixing his match, taking aim, and firing, and, if successful, in hitting the target, which is known by the sound of a gong struck by a man placed at a little distance off, he walks straight up to a mandarin, seated in a tent close by, who enters his name in a book. The target is of very simple construction, being made of a piece of bar iron, bent so as to form a frame-work, about five feet high and two feet wide, the two ends being stuck in the ground. On this is fastened a piece of cotton cloth, having a mark for a bull's eye near the top. The men appeared to show much eagerness in hitting the mark and getting recorded, whether owing to a reward in money or to other advantages I could not ascertain.

These matchlocks are rapidly giving way to percussion muskets, whose superiority is now acknowledged, notwithstanding their greater cost, and the greater expense of the ammunition used with them. Even Enfield rifles are now found to some extent, and in time the

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newest form of breech-loader will, no doubt, be adopted. The jingal is merely a large description of matchlock. Two men are required to carry this weapon, and when fired, it is still supported on the shoulders of the second man. The butt is made longer in proportion to that of the matchlock, to rest it against the shoulder. It is loaded and fired the same as the smaller matchlock. The bullet is made of iron, one and a quarter inch in diameter. Another description of jingal is so heavy that two men are required to carry one, while a third man directs the aim of the piece—the ammunition is divided among the three men (Fig. 18).

Just previous to the departure of the Army of Occupation from Tien Tsin, nearly all the forges of the town were actively employed in forging jingal barrels of the largest, as well as of the ordinary size, to supply the demand for arms required for the defence of the place against the Taepings, who, it was thought would pay Tien Tsin a visit on the departure of the English troops. There was thus an opportunity of seeing the manufacture of the gun barrel in all its stages. The first stage was hammering out the thick iron into a sufficiently manageable size for twisting it into a long spiral curl corresponding to the size of the jingal—the spiral was next welded into a compact tube, and by a good deal of skilful manipulation a pretty fair barrel was produced. The next operation was to close up the breach by carefully welding in a piece—the barrel was next bored by an apparatus, like an augur, and worked in a similar manner with the hands—it could scarcely be expected that the result could be an even smooth bore when the rudeness of the apparatus is considered—smoothing the outer side of the barrel by filing, and drilling the touch-hole, completed the operation. The simple lock for the match and the wooden stock were made by the same hands as forged and made the gun barrel.

It was noticed that much English bar iron was used in making these jingals; the blacksmiths said it was very good, and doubtless it saved a considerable amount of labour, compared with the half-puddled native iron. Strange, that almost the first use to which the first imported English iron was applied, was the manufacture of these jingals!

Some regiments have a certain number of men, armed with large jingals, attached to them. They take part in the exercise at their parades, which appears to consist of a series of movements in marching and counter-marching, the whole having a pretty scenic effect, well adapted for a pantomime. During these performances the gongs are struck, and the long trumpets are blown, and the drums are beat, so that there is a din of horrible discordant sounds, which, however inspiriting to a Chinese soldier, are utterly intolerable to our ears, and are hardly to be classed as martial music (Fig. 19).

One of the exercises performed at these parades is the wielding of a large, heavy, iron battle-axe, about forty pounds in weight (Fig. 20). It is more a gymnastic exercise, and is looked upon as a feat of strength.

The cavalry are more numerous in the further north of China than in the more central or southern provinces. The country being more open, and little traversed by canals or rivers, allows of their move-

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ments. These horsemen are mounted on strong, hardy, enduring ponies, of a Tartar breed, of considerable swiftness, and capable of withstanding, without stabling, a temperature below zero in winter, and the highest heat (108°) in summer. They are, no doubt, of the same stock as the Tartar ponies met with in the Crimea, and common to the whole area of Central Asia. They stand from twelve and a half to thirteen hands high. They are bred in large numbers in Mongolia and Manchuria, and from thence they are sent to the furthest south of China for sale.

In times of emergency Mongolian cavalry are employed, and the cavalry that fought against us in the north of China during the last war were chiefly derived from Mongolia (Fig. 21). They were armed with matchlock, sword, spear, and bows and arrows, and at the engagement at Sinhoe showed considerable daring in attacking the second division, which they had surrounded; and no doubt if our army had been Chinamen, this movement, which appears to be one of their great manœuvres in war, would have intimidated us, and made us fall an easy prey. They came so close—within 400 yards—and with such a plucky, jaunty air, to the left flank of the second division, that the order was given to "form square to receive cavalry." This movement seemed to surprise them and arrest their course, and a few shots from the Enfield rifle, and some rockets fired into them, made them retrace their steps, which they did without much hurry. Their appearance right in our rear obliged us to send a couple of Armstrong guns and a company of the 67th in skirmishing order against them. They were sufficiently swift to escape from our cavalry, though we were apparently better mounted. On only one occasion did our cavalry get sufficiently close to them, and even then but few of them were cut up. The great mass escaped by their better speed. Had these men been armed with breech-loader carbines instead of their own rude weapons, they might have done considerable execution.

A Chinese saddle (Fig. 22) is a very clumsy affair, and exceedingly heavy; a saddle and saddle-cloth on trial, weighed 27 pounds. The seat is much higher, and before and behind there is a high ridge of wood forming the tree. A large piece of leather forms a flap which covers a good portion of the horse's flank, and the stirrups are very large and made of massive iron; a thickly padded cloth is worn under the saddle to prevent its chafing the skin of the horse's back—no spurs are used. They have a very severe whip, made of short thongs of thickly plaited hide, with a short handle about a foot or so in length. The bridle is in shape much like our own, and the bit is a snaffle, with large rings for movable cheek pieces (Fig. 23).

Their sword, of little value as an offensive or defensive weapon, is made of iron, is very heavy, and worn on the left side in a sheath suspended from the girdle. It is used by bowmen and spearmen, and could only be effectual in decapitating the unfortunate victim who might fall into their hands. Some bodies of Chinamen were found near the summer palace at Pekin some days after the allied army had left its precincts; they were lying on the ground, and on their backs, which were uppermost, the marks were seen of where the swords had

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been wiped, by drawing the blades to and fro, on the clothes covering them, while their heads were seen suspended by their tails from the branches of the nearest trees. For such occasions the swords are useful. Nothing appeared to excite the admiration of Chinamen so much as the elastic spring of the blades of our swords, their own being made of soft iron remain in the position in which they are bent.

Some spears were picked up on the fields on which we had encounters in the north of China. They were rather short in length, being only between 6 and 7 feet long; the heads were made of iron, having a long flat blade of about 6 or 7 inches, and terminating in a sharp point, about 1¼ inch at the broadest part. The remainder of the blade, about 4 inches in length, formed a socket which fitted on a pole 5 or 6 feet in length, made of a strong piece of wood, about 1½ inch in diameter, apparently the branch of a yew tree, and terminated at the further end by a ferule of iron. At the part where the blade was joined to the shaft there was a bunch of horse or yak hair, died a bright red colour (Fig. 24–2).

Strange that the most perfect weapons of precision, the Enfield rifle and the Armstrong gun, those great inventions of the age we live in, should, on the very first occasion in which they were applied, be brought face to face with the most primitive and the most ancient of all weapons of warfare,—the bow and arrow—and yet so it was in the last war in which we were engaged in China. That bows and arrows formed part of the military equipment of the Chinese there is no doubt, as our men were wounded by the latter, and at the northern face of Tong Ku, near the north-east angle, there was a space of 20 yards along the further side of the ditch covered with their arrows, which were stuck into the clay to a depth of 5 or 6 inches. The position of these arrows indicated at once that they had been fired by bowmen, standing inside the intrenchment below the wall. They must have been fired almost straight up into the air, as they all stood nearly upright, being inclined at an angle of about 15 degrees from the perpendicular. It is thought that they were meant to hit some person supposed to have approached near the place during the night to make a reconnoissance, and had he been in that particular place, it was impossible that he could have escaped. The number of bows and arrows found in the numerous guard-houses about the summer palace was very surprising, the defence of this important place, being apparently altogether confided to bowmen. Against an unarmed mob they would no doubt prove effectual, but before the common musket they must have been perfectly useless. Even against their own clumsy matchlocks they would stand but a poor chance, notwithstanding the rapidity with which they could be used.

Some of the arrows had a wooden hollow ball, instead of a point, this, when shot off, made a noise like a whistle and could be used as a signal; another form appeared to be made use of to set fire to buildings by means of a firework attached to the end of it.

Proficiency in the exercise of the bow and arrow is essential to qualify for promotion to the higher grades in the Chinese army, and accordingly, much practice is required in order that the candidates

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may show themselves sufficiently expert. Du Halde tells us that the military mandarins, or officers of the army, must pass several examinations as well as the literary mandarins, and give proof of their strength, dexterity, and experience in the art of war; accordingly there are three degrees among them which they are to take, viz., those of bachelor, licentiate, and doctor of arms. It is curious to notice that even in the exercise with the bow, a particular formula had to be observed in the way of position, which appeared to be even more elaborate in all its details than the position drill of the match-lock. The exercise with the bow on horseback was very exciting, and really deserving of admiration. It was as follows, a space of about 200 yards of level ground was selected, and at the distance of every 50 yards there was a bundle of straw erected, the size and height of a man. The horseman, his bow and arrow ready (Fig. 25), started his horse at full speed, and as he passed within ten yards of the first bundle of straw he shot his arrow at it: then taking out another from his quiver or from the belt into which they were inserted loosely, he shot it at the next bundle of straw, and so on in succession, until he passed the last bundle, when his pony, who had continued at full speed throughout, stopped immediately, being trained to do so, as soon as his withers were touched by his rider's hand.

It requires a considerable amount of strength to pull a Chinese bow, it being made of very unyielding materials, chiefly thick bamboo, strengthened by a thick layer of buffalo or ox horn on the inside. So strong is the bow, that the string requires to be made of cat-gut nearly half an inch in thickness. It is efficient enough to kill a man at sixty or eighty yards. It is held in the left hand, and the string is drawn up to the right ear. The arrows are about 32 inches in length, armed with iron heads of various forms, round, square, and flat. The shaft is made of deal, half an inch in thickness, and feathered at the end with three feathers. It is not unlikely that even now, bows and arrows worn as of old, in bow-rack and in quivers, form the equipment of portions of the Chinese army in the further north. At a time when such weapons were used exclusively, shields and armour were no doubt of use, but they were not employed in the last Chinese war. Men armed with shield and sword appeared among the Taeping rebels. The shield was made of bamboo, plaited thickly together, and could resist an arrow or sword cut.

At the capture of the Taku Forts, several cross-bows were found, and some of our men received wounds from short arrows projected by them. The dimensions of these bows were very small, the bow being hardly 22 inches in length; and the barrel, which was covered over throughout, with a slot for the string of the bow to move in, was about 12 inches in length (Fig. 26). As a weapon of either offence or defence, it was wonderful how any reliance could be placed on what boys would hardly be proud to play with as a toy; and yet they were found there, and they were used in projecting arrows about eight inches in length, and having a sharp iron point at their extremity. The cross-bow was a form of weapon used to a great extent in the

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ancient wars of China, and old prints have representations of very large ones mounted on regular stands.

Such is the nature of the equipment of the Chinese army, and with which they have hitherto carried on war. Of late years a great change has been attempted, and an effort has been made to adopt the appliances and the methods used by western nations. The futility of their own arms against those of the Allies in 1860, no less than the wonderful efficiency of a small force of Chinese, disciplined in a rude way, and armed with weapons of a superior description to their own, in contending against the great Taeping rebellion, which shook the stability of the empire far more than the foreign invasion, made the Chinese Government alive to its danger, and the necessity of a change in its military system.

In the spring of 1862, a request was made by some Chinese officials to Brigadier-General Sir C. Stavely, then commanding at Tien Tsin, for permission to allow Chinese soldiers to be taught the European method of drill and manœuvring in the field. This request was acceded to by the British Minister at Pekin, to whom it was referred; and a number of Manchu soldiers, under their officers, numbering about 100, were put in the hands of several drill sergeants of the 67th Regiment, under the adjutant. They commenced with the usual initiatory goose step, just as if they were recruits joining one of our own regiments, and soon their ears became familiar with "Wan, Tow," "Wan, Tow," pronounced in the barrack square vernacular, and so with the other words of command, which were all given in English. In time they could pronounce these words themselves, and continued to use them when they became drill instructors to their own men; and not long since a regiment of Chinese were seen going through the movements of battalion drill at Pekin, when the words of command employed were English, and not Chinese. It is, therefore, quite possible, that in future ages ethnologists may begin to trace an affinity between the Tartar and Anglo-Saxon races, by discovering traces of several English words which have been engrafted on the Manchu and Chinese languages.

These men above-mentioned were armed with rifles of the regulation Russian pattern, five hundred of them having been sent as a present from the Russian Government just at that time. During the rest of the time of our military occupation in the north of China, there was a considerable body of Chinese troops undergoing instruction under our officers; and on one occasion, when the Shantung rebels made an incursion into the province of Chili, a large force, consisting of some foreign-drilled regiments, were sent against them under the command of Major Coney, 67th Regiment. This force succeeded in driving the rebels out of the province, and proved the advantage of their modern equipment and instruction, in a sufficiently satisfactory manner.

On the arrival of the 67th Regiment at Shanghai, in 1862, a similar request to have the local troops drilled after our fashion was made by the governor of the city, and a regiment was at once recruited for this special purpose, and placed under the command of Captain Kingsley, 67th Regiment. The inferiority of their physique compared with that of the more northern Chinese was at once seen, and it was some time before they could understand the utility of the goose-step movement, which

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they manifestly regarded as an imposition, and looked upon as a most irrational mode of wasting time. Their further progress, however, was more satisfactory to them, and when they got to the advanced stages of battalion drill, they showed sufficient expertness and steadiness after a good deal of drilling.

Subsequently a large body of troops was placed under instruction at a short distance from Shanghai, and a regular camp of instruction was afterwards formed, under the command of Major Jebb, 67th Regiment, and the men were instructed in battalion drill and artillery practice. Some of these men were sent to the front during the operations against the rebels, under Colonel Gordon, and did good service; and subsequently they became the means of instructing the troops under command of Chinese officers. The words of command having been translated into the local Chinese dialect, Chinese and not English words of command were used. They at first adopted a modernized dress, made of blue serge cloth, somewhat after a European pattern, and wore a turban of black, red, or light-blue colour; from these peculiarities of their dress they got the name of "Imitation foreign soldier." (Fig. 27). In this respect they resembled the troops immediately under the command of Colonel Gordon. As this appeared to be too great an innovation for the Chinese, the troops who were subsequently under instruction, were dressed after a more national manner, being, however, strictly uniform as to the colour of the coat, breeches, leggings, shoes, and turban, also as to the material and shape. Some coats, however, were not buttoned over the right breast, but joined in the middle. The men were of course equipped with a musket—the old Brown Bess, with a percussion lock—or with a few Enfield rifles. This entailed cross-belts or waist-belts, to carry the ammunition pouch and bayonet; but in other respects they only differed from the matchlock men of former days in being more tidy and better clothed, as seen in the accompanying illustration (Fig. 28), in which the local country fashion of shoes, leggings, and breeches are used, the jacket being the only military part of his dress.

At the camp of instruction at Fong wan Shan under Major Jebb, were two stockades, containing about 500 men in each, besides 200 artillery. Of these there were 150 armed with the Enfield rifle, and the remainder with the old musket. For the artillerymen there were 4 howitzers, 4 mortars, and 3 rocket-tubes. There were five English officers, who carried on the instructions under the command of Major Jebb and an interpreter.

The men rose for roll call.	5½ A.M.
Parade and drill	6 A.M in summer, 10 A.M. winter.
Breakfast	8 A.M.
Dinner	4 P.M.
Parade	5 P.M. in summer, 3 P.M. winter.
Bed	9 P.M.

There were a few men instructed in the bugle, who gave the usual calls for drills, parade, tattoo, and exercise in light infantry drill as in

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our own regiments. The native officers of a battalion under the Commandant Yuen, consisted of a major, who always appeared on parade in command, an adjutant who performed the duties of adjutant and sergeant-major, 4 captains, 4 lieutenants, 4 sergeants; each captain had command of a company, which seldom mustered more than thirty men or so on parade, at a time, he had also a lieutenant under him and a sergeant and three corporals. The native officers lived in quarters in the village close by, while the commandant remained in his stockade. They were all very little different in appearance from the men they commanded, except in dress, which was peculiar (Fig. 29). They may have been perhaps smarter and more intelligent than the privates, and were no doubt derived from a better class of the population.

The physical character of the inhabitants of China varies very considerably throughout the continent. The Cantonese is strong, muscular, broad-shouldered, and short in stature, his limbs being well-proportioned, and capable of considerable endurance and labour. Some of these men added great strength to the Taeping rebels, and were an important element in their army organization. The people of Shanghai and the province in which that city is situated (Kiangsoo) are comparatively speaking, very effeminate in character, of slender build, and less muscular than either the Cantonese or those of the provinces situated further north. As soldiers they are very inferior. Those of the provinces of Chili and Shan tung are tall well-made men, and the obstinacy with which they fought at Taku and elsewhere, shows that they have no mean qualities for soldiers. They also appear capable of very laborious work, requiring good muscular development, as seen by the enormous loads they carry as water-carriers or coolies in the streets. The Manchus are a fine race but not very tall. The Mongolians are of smaller stature. The tallest troops in the north of China appeared small when standing beside our artillerymen. By far the smartest and most military looking body of men, although not of very large stature, which I saw in the camps near Shanghai, and in the large number of troops collected before Suchow and elsewhere, were the men from the province of Honan. The Honan regiments were always smart and clean looking, the men had a better expression of countenance, and were cleaner limbed, and carried themselves better than the men of other regiments. Those who have seen the Chinese soldier in action, bear testimony to his good qualities; and though in attacking a strong position he requires to be led by men of a more courageous race, he still follows; and an instance occurred where Chinese soldiers stormed the breach after being repulsed twice previously in succession at Taitsan. The death of a comrade does not appear to inspire fear in the man standing beside him, on the contrary, a hearty laugh generally is the result, and though better behind walls, these soldiers do not hesitate to go to the front when required.

On the capture of a place the Chinese soldier is utterly unrestrainable, he fires off his musket at any object, even into a house when there is no necessity for so doing; his great ambition is to cut off heads, and old men or children soon fall victims to this insatiable desire. His cruelty is the cruelty of a fiend, and the unfortunate

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captives taken in war time are treated with the most barbarous cruelty, such as tying to a stake and cutting off, piece by piece, flesh from the limbs, gouging out the eyes, taking out the tongue, cutting off the ears, &c.: some have been seen stretched on the ground and fastened to stakes by the hands and feet, and the head also made fast by the hair to a stake in front, while burning spars of wood were placed under the victim's neck. To decapitate a man is a great object of ambition, and for this purpose every man carries a long knife or short sword (Fig. 30) behind his back, fastened to his girdle, and it is wonderful how expertly, or rather how easily a head may be cut off. I have seen some men, who have recovered, with the marks of fearful gashes at the back of the neck. Next to satiating his cruelty, his impulse is to loot, and a story is recorded that, after the capture of a city from the Taepings, the captives were made to carry the bundles of loot, and on arriving at the Imperialists' camp, had their heads cut off by way of recompense; but this perhaps is one of those exaggerated stories which have been told against the Imperialists, who certainly were not less cruel than the rebels. The Chinaman is peculiarly submissive to correction; when beaten by whip or bamboo by way of punishment, and while still smarting under the infliction, his first duty is to thank the officer who orders him to submit to it, and even on suffering decapitation, instances have occurred where he has been seen to kneel down and bend his head for the executioner's knife, on hearing the order of a mandarin.

They are expert thieves, and frequently band together for robbery. They turn pirates without hesitation when an opportunity offers, and make no more hesitation or scruple in fighting against people of their own province, than if they were foreigners. Colonel Gordon employed the rebels he captured, in his army, and found them ready to fight their comrades the day after they were captured. Naturally industrious to an extreme degree, and given to peaceful trading or mechanical occupations, they lose all such habits after a short time, when employed on active service or even in camp life. A large army is hence a source of great anxiety to the state, as the soldiers being unfitted for peaceful pursuits, when disbanded, become too apt to be lawless, and turn to piracy or brigandage; so much so is this the case that a severe winter, or an epidemic of cholera is regarded as a great ally to the Government in decimating disbanded men, who are looked upon as useless members of society, and who being without recompense for their services, or without pension, must live a life of indigence.

The Chinese soldiers have shown great respect for and even attachment to the English officers who have had command of them. Besides the skill with which they were commanded, and the confidence superior courage inspired them with, there is no doubt that the great charm which made the Chinese serve so willingly under them, was the correctness and punctuality with which they received their pay. When a Chinaman finds that he gets his pay regularly and exactly, he is most faithful and loyal as a soldier, a servant, or in whatever other capacity he may be employed; but let there be incorrectness, or long arrears,

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or let anything occur to arouse his suspicion, and he becomes an unsafe and untrustworthy agent.

In conclusion, let us see what is the present position of the Chinese empire as to its military organization? We have seen the miserable condition of the equipment of their army up to 1860, which they themselves have acknowledged, by showing a desire for adopting the equipment, and the drill in use by us. Their efforts might have been more energetic, as the importance of army re-organization, as an element of governing their own people, no less than as a defence from foreign aggression, must be easily seen by the existence of desolating rebellions in nearly all the provinces, while foreign nations are making repeated encroachments on their continent. But what do we find? The men who were drilled with so much trouble and anxiety are not paid. They go over to the rebels, and take their arms with them. The old commandants have sufficient influence to make the modern drill be treated with indifference, and to preserve their old customs and equipment. The rebellion has been subdued in the central provinces by the aid of foreigners; and the Taeping strongholds, including Nankin, the ancient capital of the empire, which had fallen into their hands, have been re-captured, but rebellion continues rife in other localities, and even now large armies are in the field. A governor of a province, for whom the suppression of rebellion is a plea, who maintains a large army instructed in foreign drill, equipped with foreign muskets and rifles, and what is far more important, having an efficient artillery under foreign officers, and a means of supplying it to any extent with modern ammunition from a well arranged laboratory, is at this present moment in a stronger position than the central Government itself; he being able to make the great revolution in army organization, which the central Government cannot do on account of the trammels of ancient institutions, prejudices, and interests, which hamper all its movements. The opportunity cannot be far distant for a man in Lee Fu Tai's position to show the central Government of Pekin its utter helplessness, and make it yield to his ambition, and the history of China may again record one of those dynastic changes which have so frequently occurred before.

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Evening Meeting.

Wednesday, May 1st, 1867.

CAPTAIN E. GARDINER FISHBOURNE, R.N., C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between April 29th and May 1st, 1867.

ANNUAL.

Wells, Richard, Captain R.N. 1*l.*
Harington, Richard H., Comr. R.N. 1*l.*
Comber, H. William, Comr. R.N. 1*l.*
Cottam, Geo. F., Comr. R.N. 1*l.*

THE TURRET VERSUS THE BROADSIDE SYSTEM.

By Captain COWPER P. COLES, R.N., C.B.

WHILST endeavouring to explain my views upon a question that all interested in upholding our maritime power are so deeply concerned in, I feel you will grant me your kind indulgence and a patient hearing, remembering the ordeal that my invention has already gone through.

The title of my lecture, "The Turret *versus* the Broadside System," may appear somewhat out of date, since it is now generally admitted that the turret principle for fighting purposes is the right thing, and it only remains to be decided *which* is the best description and class of vessel for carrying and fighting these turrets under all circumstances for the protection of our country, of her vast commerce, and of her colonies.

I intend, 1stly, to give an outline of the various vessels proposed by me since 1855, and those built or building on my principle.

2ndly. To show the advantage of the turret system.

3rdly. The further conclusions I have arrived at, showing the type of vessel I now propose, in order to meet the demands of the increased and still growing power of ordnance.

Description of Diagrams.

With the assistance of these diagrams I will endeavour to give an outline of the peculiarities of these vessels, dealing with them above water only, for supposing the form of ship's bottom to be good for either broadside or turret ship, I will allow it to be common to both, remarking that I consider it indispensable for fighting vessels to have either twin screws or the hydraulic propeller, for which we are indebted to Admiral Elliot. The means of propulsion by two separate powers

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Fig. 1.

STEAM RAFT.

Fig. 2.

CUPOLA SHIP.

J. Jobbins

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enables the vessels to turn on their own centre, and thus meets to a very great extent the objection to length.

Fig. 1 (Plate xxxi) is the steam raft proposed by me when up the Black Sea in 1855, for attacking the forts of Sebastopol and Cronstadt; she was to be 150 feet long, only 20 inches out of water, and to carry one 68-pounder, protected by a fixed hemispherical shield of iron.

From my experience with the "Lady Nancy" raft up the sea of Azoff, I was convinced that low freeboard with central armament had great advantages for fighting.

This led to cupola ship, Fig. 2, in 1859, of the same tonnage as "Warrior," carrying nine cupolas with eighteen of the heaviest breech-loaders of that day; the bow and stern cupolas were placed diagonally, and raised somewhat higher than the others, so as to bring four guns right ahead and astern.

Admiral Halsted, a great authority in these matters, is now strongly advocating this plan.

Fig. 3 is the "Royal Sovereign." She and another vessel, the "Prince Albert," were commenced in April, 1862.

At this time the 12-ton gun was tried at Shoeburyness, against the "Warrior" target, when the shot went through it. In consequence I at once applied to the Admiralty to be allowed to provide for two heavy guns in each turret, but they then thought it impracticable to work these heavy guns afloat. However, by perseverance and a compromise of *one* gun for *two* in the turrets, I succeeded at last in getting these two ships armed entirely with 12-ton guns. But it was *eight* months before I obtained permission to fit the "Royal Sovereign," and *one* year and *nine* months, the "Prince Albert." Thus much time was lost, extra expense incurred, and the ships rendered less effective than they would have been had my views been at first favourably considered. The "Royal Sovereign" has now *three* single and *one* double turret, carrying *five* guns; she should have had *three* double turrets and *six* guns.

The "Prince Albert" has *four* single turrets and *four* guns; she should have had *three* double turrets and *six* guns.

The "Royal Sovereign" would thus have had one gun more with 113 tons to spare, and the "Prince Albert" two guns more, with 45 tons to spare, which in both cases would have given increased room and accommodation. These are very formidable vessels, and would destroy any ships of their own tonnage; but should be fitted with hurricane decks, when they would be efficient for any emergency.

The "Royal Sovereign" was first tried in 1864, under the command of Captain Sherard Osborn. It would be presumptuous in me to remark on the very severe tests to which the turrets and their guns and appliances were subjected by that experienced and unprejudiced officer on that occasion, but I am sure all who know the circumstances will agree that the country is much indebted to him for his report, which to this day remains uncontroverted.

§. 9 of the report says:—

"To recapitulate, I am of opinion that the 'Royal Sovereign,' as she now stands, is the most formidable vessel of war I have ever been on board of. She

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would easily destroy, if her guns were rifled, any of our present iron-clads, whether of the 'Warrior,' 'Hector,' or 'Research' class. Her handiness, speed, weight of broadside, and the small target she offers, increase tenfold her powers of assault and retreat; and I believe I see my way to firing, by night, from a turret with as much accuracy, as by day, so long as the enemy is visible."

§ 11:—

"Vessels like the 'Royal Sovereign' are admirably calculated for the defence of the coasts, harbours, and roadsteads of Great Britain. With twelve such converted vessels, the fleet might be sent abroad to fight an enemy, and we could feel secure at home come what might, the more so as any naval officer would undertake to work and fight these vessels if manned by artilleryman, with only a dozen sailors to steer and take the lead."

So wrote Captain Osborne in 1864.

In 1862 I proposed Fig. 4, a sea-going vessel, with a belt and square central box, carrying two turrets.

Another vessel on this plan was, in conjunction with me, designed by Mr. Barnaby, of the Controller's Office, in 1863, 280 feet long, 3,700 tons burthen, 24 feet draught of water, and 10 feet free board; had two turrets carrying four 300-pounders, 4½ inch plating, and "Warrior" backing, with a speed of 12½ knots, fully rigged with tripod masts, and spread 28,000 square feet of canvas. She would have been a formidable vessel, capable of cruising to all parts of the world, and have fully tested what a sea-going turret-ship could do. But the anti-turret party—and in using that phrase for convenience and in all good humour, I trust I need hardly disclaim the intention of reflecting upon any one—the anti-turret party were then too strong to admit of a fair trial of a sea-going turret-ship being made.

Fig. 5 (Plate xxxii). This arrangement of armour was proposed in 1863, and alternatives again in 1865. The portion coloured red in all these diagrams is unprotected, and may be riddled by shot without affecting the safety or efficiency of the vessels. That portion painted black is protected by armour. This vessel has a belt, the turrets being carried on the upper deck, and two methods are shown here for protecting the pivot, the after one being carried down through a small circular casing and worked on the lower deck. The foremost turret is supported by and worked in a circular bulkhead, admitting of the turrets being placed at the most convenient distance apart. I have several modifications of these alternatives, which are commendable for small, light vessels, or should a high free board be thought desirable for any special purpose. In the unprotected portion of this ship might be carried a few broadside guns, for signal guns or exercise, and to "teach the young idea how to shoot." She would be a very roomy vessel for carrying troops if required.

Fig. 6 shows the "Huascar" class of 1865 fitted with a hurricane deck; she is one of six different classes designed and built by Messrs. Laird Brothers, to whom the credit for their great success is due. She can fire right ahead from her 300-pounders, and aft within 15 degrees of the line of keel, but would have a stern chaser either on or under her poop.

Three of Messrs. Laird's vessels crossed the Atlantic early in 1866, and they deserve special notice.

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Fig. 5.

ALTERNATIVES. – 1863 & 1

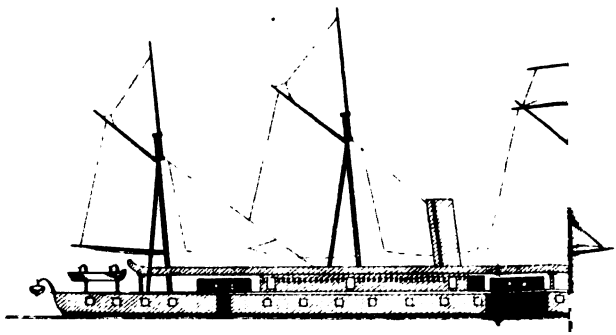
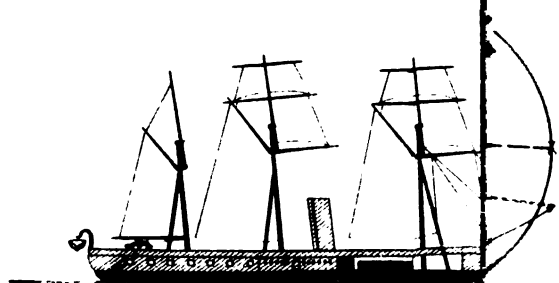


Fig. 6.

HUASCAR CLASS.-1865



J. Jobbins

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1st. The "Huascar," a sea-going vessel of 1,100 tons, 300-horse power, and a speed of 12½ knots; her foremast is fitted with tripods; she carries *two* 300-pounders in *one* turret. She made an excellent passage to Rio de Janeiro, and experienced more than one heavy gale on her further voyage to Peru. Her companion, a broadside ironclad of 3,000 tons, and *high* out of the water, made much worse weather of it, arriving at Valparaiso one day after her.

2nd. The "Bahia," twin screw vessel of 1,000 tons, 140-horse power, has a speed of 10½ knots, and carries two 150 pounders in one turret. She averaged nearly nine knots on her passage to Rio, and has since been in action on the Paraguayan River, when she was struck by *thirty-nine* 68-pounders.

On that occasion the "Bahia" (turret) and "Tamandaré)" (broadside) went into action together on the Brazilian side, and the official report of the Brazilian Admiral says:—

"The iron-clads 'Bahia' and 'Tamandaré' approached the Flat to silence it. The Flat continued to fire on the ironclads, and two balls entering the square box of the 'Tamandaré,' placed 34 men *hors de combat*, 10 being killed and 24 wounded, in the greater part severely.

"The 'Bahia' took position near the fort, and her first shots broke the Paraguayan cannon.

"The ironclad 'Barroso,' which likewise went to destroy the Flat, had 6 men severely wounded, all in her square box.

"The 'Monitor Bahia' (late 'Minerva,' of Liverpool) has no casualties reported except the wounding of the Commodore while outside the turret.

"These two vessels were struck respectively by 20 and 39 68-pounder balls at short range."

3rd. The "Bellona," twin screw vessel of 1,340 tons, with two turrets, averaged 9½ knots from Liverpool to Rio de Janeiro.

Messrs. Laird Brothers may well be proud of these little vessels; and with my views, I may be permitted, I trust, to express my regret that we should be spending money so freely upon square boxes and all sorts of broadside devices, whilst we do not try even one or two such vessels for our Navy, which class of vessels I believe would be found the most useful and economical for this country to possess.

Fig. 7 is the "Captain," designed by Messrs. Laird Brothers in conjunction with me during the beginning of 1866.

An anonymous pamphlet, which has been quoted in the House of Lords, purporting to explain the reasons for discouraging the development of the turret system from 1860 to 1866, says:—

"This vessel will be equal in tonnage to the 'Bellerophon,' and, therefore, the expectation of a small powerful turret-vessel is doomed to disappointment."

The small iron-clads which I have just described would alone furnish an answer to this erroneous statement.

I will now compare the "Bellerophon" and the "Captain," and I think those who know what fighting ships ought to be, will not, as regards the "Captain," be "*doomed to disappointment.*" The "Captain" has the same tonnage as the "Bellerophon," with 3 feet less beam; she has twin screws, draws 3 feet 6 inches less water, and her speed is estimated at 14 knots. Admitting that the "Captain's" speed will be

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equal to that of the "Achilles," we must consider what the speed of the "Bellerophon" is. She has been officially reported as having attained 14 knots at the measured mile. Such results we know to be of an unreliable character, and one cannot but inquire how it is that the "Achilles," of the same estimated speed, beat her when trying together at the rate of two miles an hour, and that she could not even steam away from the "Caledonia" or "Ocean." I confidently hope that the speed of the "Captain" will be not less than that of the "Achilles," and therefore decidedly superior to that of the "Bellerophon" at sea.

The "Captain" is of 900-horse power, stows 610 tons of coal in her bunkers, and could stow, if required, in a compartment between the turret-rooms 491 tons more, making 1,100 tons of coal in all.

The "Bellerophon" is of 1,000-horse power, and stows 500 tons of coal, shewing a far greater consumption of fuel in proportion to quantity carried. The maximum thickness of armour plating on "Bellerophon's" side is 6 inches, on the "Captain" it is 8 inches, and 10 inches on the turrets. The height of guns out of water is the same; but the "Captain" has a fighting power of broadside of four 600-pounders against the "Bellerophon's" five 300-pounders.

Thus as the "Captain" throws more than half more weight of broadside and is protected by one-half more thickness of armour I think there can be little doubt as to which ship would sink the other. The "Captain's" 600 pounders have a range on each broadside of 132 degrees for *both* guns, and of 168 degrees for *single* guns; she can bring her 600 pounders to fire six degrees from the line of keel, and carries bow and stern chase pivot-guns on the poop and forecastle; whilst the "Bellerophon's" maximum training on the broadside is at most 30 degrees each way, 60 degrees in all.

The ventilation, accommodation, and sanitary arrangements in this vessel (see Fig. 10, plate xxxvi) will be better than those in any ironclad built, and equal to those of any unarmoured vessel. Her poop and forecastle are connected by a spacious spar or hurricane deck—24 feet broad—on the same principle as those of the Cunard packets, which cross the Atlantic in all seasons. The hatchways round the funnel and amidships are of iron, and carried up to the spar deck, forming at once a support and a complete system of ventilation to all parts of the ship. Doors are fitted in the iron bulkheading, to give access to the main or turret deck, which in bad weather may be closed, leaving open the hatchways in the poop, forecastle, and spar deck, which is 18 feet above water. There is ample accommodation for an Admiral and his staff, with several spare cabins, baths, and every comfort both for officers and men; her complement will be 400, but she has ample messing room for 610 men besides officers. It will be hardly necessary to point out that this vessel was designed to meet the *comforts* considered necessary for long cruises in peace time, either under sail or steam, combining with these greater fighting powers than any vessel of her tonnage.

Looking at these two vessels in a financial point of view, I find from the Parliamentary return at starting, that the "Bellerophon" in

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Fig. 8.

TURRET SHIP. - 1867.

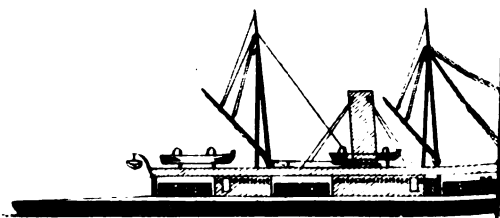
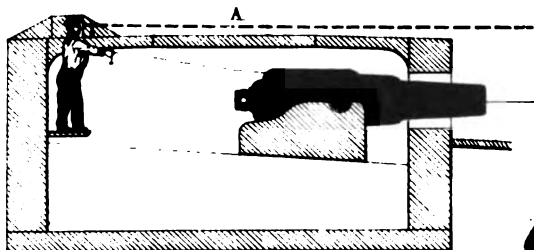
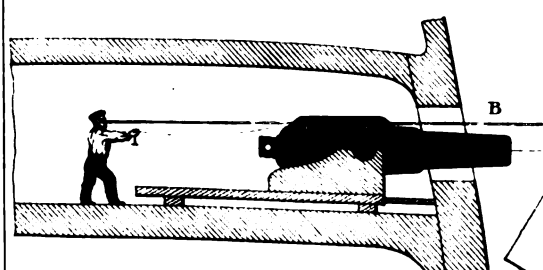


Fig. 12. TURRET



BROADSIDE.



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July, 1866, had already stood the country in £430,495. The tender for the "Captain" is £335,000, leaving a margin in her favour of £95,495. However the accounts are not yet completed. On the other hand the expense of fitting out the "Captain" for sea is not included in the estimate. Again the "Bellerophon" has a complement of 556 men—the "Captain" of 400, making a saving of 156 men, and of £11,585 per annum, with a more efficient war ship.

Fig. 8 (Plate xxxiii) represents a vessel of the same dimensions as the "Captain," having four instead of eight feet freeboard, with no poop or forecastle, but a hurricane deck, 200 feet long. The weight thus gained admits of her having 15-inch armour on her turrets, and 13 inches on her side, or a *third* turret and not so great an increase of armour. She would have the advantage of an all-round-fire from her 600-pounders, crossing at 65 or 75 degrees on the beam, and carrying her guns 11 feet above water.

Fig. 9, a smaller vessel, is an improved "Prince Albert," carrying four 600-pounders in two turrets, and heavy armour.

Small and most formidable vessels could be built on this plan, and it remains to be seen whether they will not be more efficient than those with higher freeboard, and yet be comfortable.

20 *Vessels Built and Building.*

I will not tire my audience by reading over the names of 20 ships built or building in Europe on my plan (see list in Appendix), varying from 1,000 up to 4,000 tons, but will name a few.

The "Rolfe Krake," "Scorpion," and "Wyvern" head the list. They were designed about the same time by their respective eminent builders, Messrs. Napier and Messrs. Laird Brothers.

The "Rolfe Krake" was launched in May, 1863—she has been afloat ever since—did good service in the Danish war, and fully realized my expectations.

The "Scorpion" and "Wyvern" were unfortunately seized by our Government, and not tried until the Autumn of 1865.

Some of the most essential recommendations made by me, as well as by their Captains, in order to adapt them for our Navy as sea-going ships, were not carried out, and consequently they have never had fair play.

In this list, besides the "Smertch," of 1,200 tons, will be found six other formidable Russian vessels. They vary from 1,626 up to 2,170 tons, carrying from two to three turrets, with two 300-pounder breech-loaders in each. I will dwell no more on these 20 specimens, beyond telling you that their aggregate tonnage, leaving out the "Monarch," is 16,204 tons, with a weight of broadside of 12,000 lbs., and requiring 1,392 men to man them.

It has been asserted that there is no great economy in turret ships, but I ask any one to produce the same amount of broadside tonnage that could compete with these 19 ships. To produce the same power of broadside, viz., 12,000 lbs., as thrown by these turret-ships, the

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broadside system would require 36,000 tons of shipping, shewing an increased expense for their construction, of £1,572,782, besides necessitating a greater consumption of fuel, and a greater number of men, amounting to 3,124 more, costing £238,539 per annum.

It may be said that it would be impolitic to reduce the number of men we keep up in the Navy, but at all events *now* that men are becoming yearly more expensive and scarce, it appears to me to be of the greatest importance that we should be able to man *more* ships with *fewer* men.

Area of Ports.

I will now explain some of the advantages possessed by guns mounted in a turret.

This transparency (see Fig. 11, plate xxxiv) shows the respective open area of a broadside and turret port for a 300-pounder.

It will be noticed that there is an open space between the top of the turret and the hurricane deck, whilst the broadside is continuous to whatever height the upper deck is carried.

The muzzles of the guns when run out fill up a portion of the ports, but the increasing circumference of these guns towards the trunnions closes the interior of the turret port so that it cannot be seen through, hence arose my idea of taking aim by sights placed on the top of the turret, one of the greatest advantages inherent in my system. I have three sights on the top of each turret in case of one being damaged, but space only admits of two being represented in the diagram. It will be seen that the gunner's head, when taking aim, is protected by a circular disc (*a*), as well as by the hurricane deck (*b b*) over the turret, which prevents his being seen or picked off by riflemen from aloft. The sights are placed in a line with the axis of the bore, some 9 or 10 feet apart, and the gunner's eye is close to the rear sight (see Fig. 12A, plate xxxiii); he has a clear range of vision through the aperture, but if needs be, he can look over the top of the disc, and search the whole horizon for his enemy; this arrangement is found of great value when objects are moving.

In a broadside ship the captain of the gun has to take aim through the port, his range of vision is confined to that area (see Fig. 12B), and in general he has to depend upon a message from the upper deck, as to where about the enemy is. The sights are only some 3 or 4 feet apart, which disadvantage is increased by the necessity of his standing 14 or 15 feet from the port, and a great distance from the sights (see diagram). In proportion as the gun is trained or elevated, this inconvenience is greatly exaggerated by his area of vision being decreased, besides his having to move about right and left to search for the object, causing unsteadiness and delay.

We will now suppose both guns fired and run in, when the men step up to load; it will be seen how much more exposed they are in the broadside than in the turret. But the turret port at the instant of firing can be turned away from the enemy's fire, and is thus practically closed in seven seconds, and secured from the chance of the enemy's

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BROADSIDE.

HURRICANE DECK.

b b

Fig. 11.

a

TURRET.

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missiles entering in fifteen seconds, when it will have been trained 90 degrees

During this time the loaders in the broadside are entirely exposed, and in the American War, guns were prevented from being loaded by riflemen, one instance I will quote, viz., the "Arkansas," ironclad, when passing the United States gunboat, "Scrota." The Lieutenant in command of her officially reports (see page 344).

"At the same time I opened a brisk fire with all my small arms against his ports, which, I am confident prevented them from manning her port guns till after she had passed us.

"I observed one man, in the act of sponging, tumble out of the port, sponge and all, evidently shot by a rifle ball."*

Under the most favourable circumstances even shot of 300-pound weight are no joke to handle; another reason why the turret-gun is more easily loaded than the broadside, is that the muzzle of a turret-gun is 3ft. 8in. from the side of the turret, when in for loading (see Fig. 12C); the broadside gun is not more than six inches in (see Fig. 12D), and this defect becomes still greater when the gun is trained, for the loaders can only stand on one side the muzzle, and are obliged to crouch into the port to load at all. The gun and port in a turret being constant to each other, however much the gun is trained, the space for loading is always the same, also enabling you to have apparatus for loading and hoisting these heavy shot up to the muzzle of the gun, a difficult thing to manage on the broadside.

We will now suppose a minute and a half to have elapsed whilst both guns were being loaded. The turret is revolved on the object, whilst the gun is being run out, and supposing both guns are again run out, you will have observed that the broadside port will have been facing the enemy, entirely open to the entry of shot or shell during the whole period, whilst the turret port will only have been but partially exposed for at most 30 seconds, and fronting the enemy only when firing.

We will take, for instance, the "Bellerophon," with five ports of a side, and supposing 60 rounds to be fired at the rate of one round in a minute and a half, she would have 59 superficial feet of open port-hole exposed to the enemy's fire for an hour and a half. Whilst the turret-ship with an equal number of ports, and firing an equal number of rounds in the same time, would only have 24 superficial feet of open port *partially* exposed to the enemy's fire for 30 minutes, leaving the chances of shot entering the "Bellerophon's" ports seven times greater than that of the turret. However, it may be said, what need to fire into the ports now that Palliser's shells have penetrated ironclads' targets at *right angles*? true, but as we know the chances of penetration decrease in proportion to the incline of surface presented by the armour, and the broadside ship must keep herself nearly broadside on to fight her guns, the open port and greater area of flat surface presented at a right angle will both tell much against her, whilst

* Now that breech-loading small arms are becoming universal, I believe loading these guns at close quarters will be impossible with open ports.—C.P.C.

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the turret-ship can fight all her guns at an angle of 60°. I think there can be no comparison as to the great advantage the turret would have on these points, and I feel convinced that all practical seamen gunners will agree when I say that, supposing all other points to be equal, this would be sufficient to decide the fate of any action.

The great precision and *rapidity* of fire that the turret-gun must have over the broadside in actual practice of heavy ordnance, if even tested by competitive firing, will amount to a greater superiority than was experienced with the 40 pounders in the "Trusty," which Captain Powell thus reported of in 1861.

"The cupola gun beats the gun between decks in every description of firing, but it shows its decided superiority when the object is moving, or the ship veering about. I think their Lordships will find that twelve rounds were fired at different targets in a quicker time than as ever before been recorded."

He summed up the advantages as follows:—

"1. Great accuracy of practice, which may be attributed to the facility with which the sights are got on the object.

"The ease, quickness, and precision of training, and the captain of the gun giving his undivided attention to pointing.

"2. The rapidity of fire, particularly at a moving object.

"3. The quickness with which smoke clears away from the sights, with the slightest air.

"4. The large angle of training, which may be taken at between ten and eleven points. This not only gives a greater opportunity of firing, but allows a ship with shield guns to present her bow to the enemy, thus presenting a smaller surface, and at an oblique angle. It also gives the option of putting a ship's head to the sea to steady her.

"5. A perfect system of concentration may be adopted.

"6. The cupola gun requires fewer men generally, and with the exception of three numbers, the crew need not be so highly trained as at other guns.

"7. In the event of explosion, or of the armour plates being driven in, the casualties would be limited to where the accident happens.

"Forming my opinion of it as it is, both in its offensive and defensive capacity, I consider that it is one of the most formidable inventions adapted to naval warfare, as well as coast defences, that has ever come to my notice.

"I have, &c.,

(Signed) "Ashmore Powell, Captain, R.N."

So said Captain Powell in 1861.

A Steady Gun Platform.

The next advantage of the turret system that I must deal with is, a steadier gun platform, ensured by lowering the freeboard to the minimum, which is practicable only when adopting the central armament principle. This, with the monster guns now coming into fashion, becomes, above all, the most important point; for, however powerful your ordnance may be, an unsteady gun-platform renders them comparatively useless.

We find a good example in the "Miantonomoh," which vessel, on crossing the Atlantic, rolled 7°; whilst her escorts, broadside vessels, with high freeboard, rolled from 18° to 21°; and we also hear of our broadside

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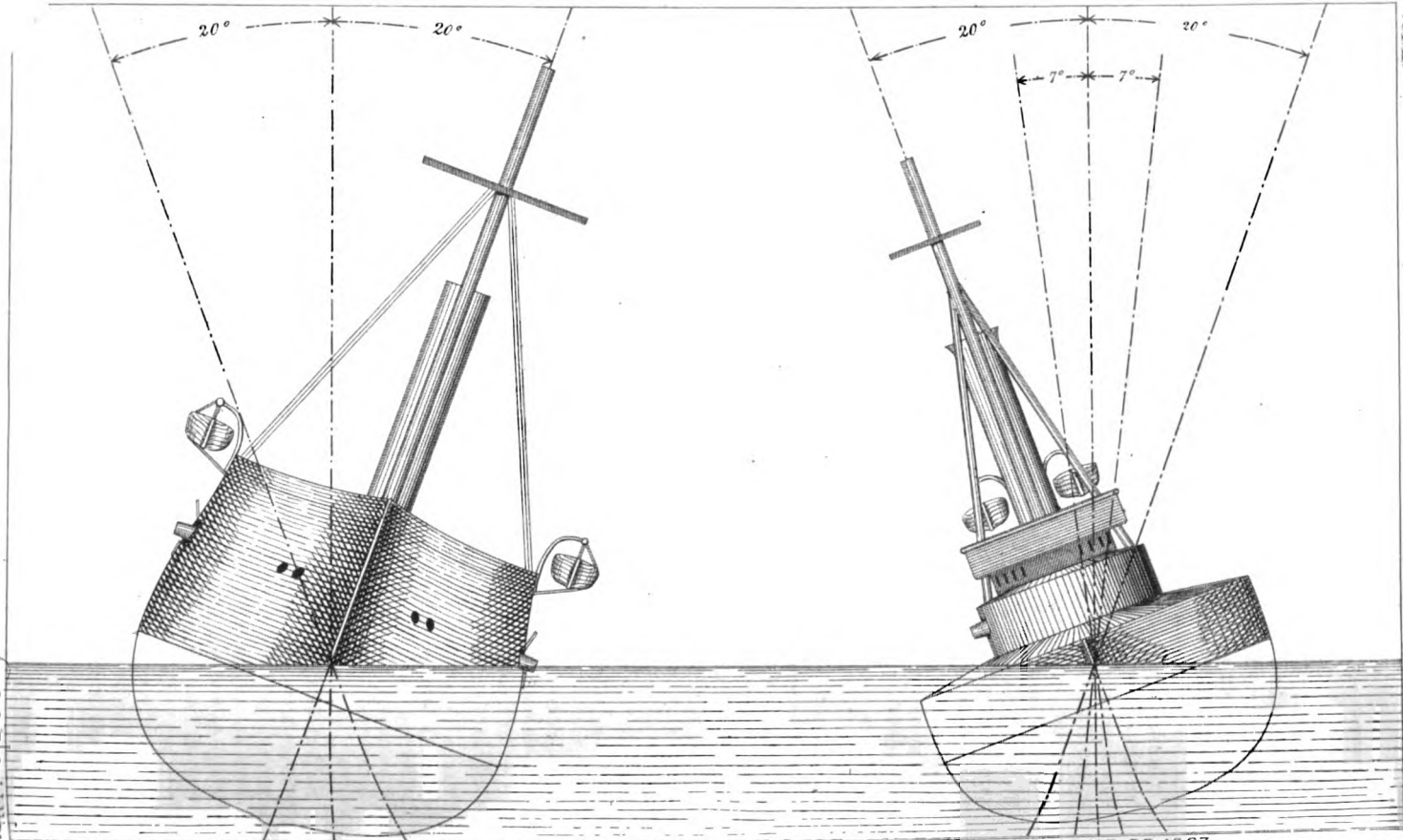

BELLEROPHON

TURRET SHIP OF 1867

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ironclads rolling to such an extent, that they roll the shot out of their guns. It is, therefore evident, that supposing vessels equal in all other respects, that with a low freeboard would in a sea-way destroy the broadside ship which, even if she did manage to keep the shot in her guns, would have a sorry chance of hitting the low turret-ship.

Various reasons may be given for the absence of rolling in such turret-ships, but I attribute it mainly to the weights being central, and their lowness of freeboard; for whilst the sea running up a ship's side, or bow, exerts a power to make that ship roll or pitch equal to the height out of water, it is reduced in proportion to the lowness of freeboard, until, taking the extreme of a vessel nearly flush with the water, as in diagram No. 1, of 1855, the sea has little or no effect upon her, but merely washes over her deck, and expends itself, as it were, on a breakwater, enabling, as I shall show, the gun in the central turret to be fought, when one on a broadside ship could not, because the water could not be kept out of the port, and little or no aim could be taken, from the large space through which the muzzle of the gun moves. The great rolling of the broadside iron-clads is too patent to dwell upon, but I am within the mark, when I say that their average rolling is three times greater than that of the "Monitor's."

It will be seen by Fig. 13 (Plate xxxv) that supposing both ships roll 20°, the gun of the broadside ship is buried in the water, whilst that of the turret-ship is free; but this is putting the ship with low freeboard at an undue disadvantage, as the turret-ship with low freeboard only rolls one-third as deep; we will therefore place her at 7°, her extreme roll, and the other at 20°, when you will see how great her advantage will be. Another most serious disadvantage in the deep rolling is, that it exposes the unprotected part of the ship's bottom below the plating, when one unlucky shot might sink her.* It may be reasoned that fighting an action in a heavy swell is an exceptional case; but there is always more or less swell in the Atlantic, and a very little gives these broadside ships sufficient motion to vitiate their aim.

A letter from the "Favourite," a square box iron-clad of 2,000 tons, dated Halifax, May 13th, 1866, says:—

"At 24 hours' notice we were sent off here instead of to the Pacific, we got here in 16½ days, without having experienced a heavy swell, the ship rolls so deep that fighting guns, except in smooth water, would seem to be a difficult matter. Her maximum roll was 25° one way, and 30° the other. We found here the 'Miantonomoh,' during the worst weather they have had, she rolled only 2 or 3 degrees."

So that had the "Favourite" been met by a vessel carrying one 300-pounder on a steady platform, she could have been destroyed with impunity.

Low freeboard and light ends has the same beneficial effect on pitching as rolling, for the sea running up the high bow tends to make it rise, and receding causes the ship to pitch with a heavy jerk or send; but with low freeboard the water breaks over the bow, and

* Admiral Sir Sydney Dacres, I find, points this danger out in his Report on our Ironclad fleet in 1864.—C.P.C.

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passes off on either side of the sloped deck, and the vessel being comparatively easy, when steaming head to sea, the screws will be less liable to be lifted out of water; besides, the little resistance which is shown to the sea will give a great advantage in speed.

The Cigar ship is an instance of the advantages of low freeboard. I hear that she rolls but little, neither does the sea ever break on board her; and it is an extraordinary fact that the low freeboard of turret ships, which has been used as an argument against them, now proves to be one of the greatest advantages and reasons for adopting it.

I have no doubt that you have heard of the enormous wave thrown up by the "Bellerophon's" plough bow; her loss of speed in a sea-way argues in favour of low freeboard. She, like other broadside ships, has to carry weight on her bows, to try and get a gun to bear forward beyond the 29 degrees of her broadside ones; but of what use could they be when steaming head to sea, even if they could fight guns in them, which, from the form of the bow, practically could not be done, and the ports must be shut to keep out the water.

It is generally supposed that these turret-ships must be uncomfortable; but when fitted with good and spacious hurricane decks, 18 feet out of the water, my 25 years' experience at sea, in all classes of vessels, tells me that they will be the easiest, and consequently the most comfortable, vessels at sea, with roomy and well-ventilated accommodation below for their less numerous crew. We have the official record that the "Monitors" were the most healthy vessels during the last American war.

I had prepared this paper to explain how abortive it is to place heavy guns in the broadside of ships; by accident the time for reading it was postponed: since then, reports of our iron-clads by two Admirals, both practical seamen, have been published, with the remarks of the Controller of the Navy on them.

They are the first reports published of actual practise at sea with heavy guns on the broadside. Great service has been thus rendered to the country by the Admiralty and the officers who made those unprejudiced reports.

Firstly, Admiral Yelverton says:—

"2. On leaving Portland, September 20th, the wind was fresh from the westward, and had been blowing hard from that quarter for several days; I therefore found a very heavy sea and swell to the westward of the Lizard, so much so, that I decided not to attempt to beat against it, but try the merits of the ships, simply as steamers proceeding under adverse circumstances to a certain point, maintaining a given moderate speed, and preserving, as near as possible, their exact formation in order of steaming, so essentially necessary for the performance of such steam tactics as might be required, had we been in search of an enemy.

"The 'Pallas' and 'Research' were the only two ships that could not keep company with the squadron; the 'Pallas' appeared to plunge heavily, and carried away her jib-boom, but took her place in the squadron the following morning; the 'Research,' from her very small steam power, was out of sight at sunset, and put into Plymouth to fill up with coal.

"37. Gun-drill took place almost daily, and target practice on three occasions, when from either wind or swell, there was a good deal of motion.

"38. The power of working the guns in a heavy sea-way, and also firing at a

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target, was only carried out on one occasion, viz., 26th September, when, with view of testing how far the ships placed broadside on to the sea would be able open their ports and take advantage of the few opportunities of seeing their targets that would offer, I ordered 15 shot to be fired at them. I was fully aware of the risk all the ships ran of shipping a large amount of water, for the sea at the time was such that no wooden frigate even would have ventured to open her main-deck ports; but it was an experiment, and, as such, attended with some success, for five guns in each ship were cast loose and fired their three rounds ('Bellerophon' excepted, which fired only two shot), not without difficulty, and shipping a considerable quantity of water, to the destruction of some of the cartridges in the guns.

"39. I may here observe that the 'Caledonia' was rolling 25 degrees in the trough of the sea, and about 10 degrees or 12 degrees when head to it.

"The 'Achilles' appeared to feel it far less than any of the others, and therefore made better practice, though on this occasion she rolled from 15 degrees to 18 degrees.

"40. I do not think that on any future occasion I would venture to open a port or cast a gun loose in any of these ships rolling more than 12 degrees or 15 degrees, for beyond that, the practice would be very doubtful, and the certainty of shipping water very great.

"Placed as the squadron was on the 26th September, a good turret-ship would have been a most formidable adversary, and have done us serious injury."

Secondly, Admiral Warden says :—

"When the signal was made to get up steam and lay out targets, it was necessary to place the ship's head to the sea before it could be considered safe to send the men aloft to furl sails.

"The precaution was then taken of battening down the main-deck hatchways fore and aft, and as the practice was limited to 15 rounds, 5 guns only on the port side were cast loose, and the practice commenced.

"18. It was found utterly out of the question to fire at the target in any other position than when head on to the sea, and the time occupied in firing the prescribed number of rounds was about three-quarters of an hour. It was necessary to steam round the target once or twice to bring the guns to bear when the ship rolled to 28 degrees, whilst it did not exceed 10 or 11 degrees when head to sea. The result was, that the main deck was flooded with water to the extent of flowing over the hatchways, the water poured in and out of the guns, two shot rolled overboard out of them, and one was followed by the cartridge. Two of the guns at different times got the better of the crew, and banged in and out of the port several times with extreme violence, and two of the slides were to a certain extent damaged by it.

"19. It is needless to say that the practice was wild in the extreme, nor do I believe that at any time there was the least probability that we could have hit any enemy's ship, except by accident or miracle. I did not observe any ship, except the 'Achilles,' fire while in the trough of the sea, but she was comparatively quite steady. I have been since informed that the 'Hector' did so likewise. Nor did all the ships fire the prescribed number of rounds, the 'Bellerophon' only two, which shows a manifest desire to get their guns secured again.

"20. The result of that day's experience would seem to prove that it is possible (though certainly never desirable) to cast loose and fire these 7-inch guns in a seaway, either singly or a few at a time, with well-trained men or experienced crews; but under the circumstances of that afternoon I hold that it would have been utterly impossible to have gone to general quarters or fought an enemy's ship.

"21. To have opened all the main-deck ports, judging by the effect of opening only five, would have been to have washed the men away from the guns, and consequently they (the guns) would have taken charge of the deck by getting adrift, but with what consequences it would be utterly impossible to predict.

"The most of the cartridges, if not all of them, would have been destroyed in the guns, and the guns which could have been got off would have hurt nobody. Three

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times in the course of that afternoon did the ship roll her main chains right under, and threw the water on the upper deck. The lower sills of the main-deck ports are about 8 feet 6 inches from the water when she is deep, and a roll of 15 degrees just touches the lower sill, and 22 degrees' roll just about covers the whole port (see diagram).

"24. The experience of the practice on the particular day in question leads to the reflection, and to the very important question, 'Could a turret ship of equal 'size and power have done better, or have proved herself more efficient in powers 'of offence and defence?' and I think there are some considerations which would lead to this question being answered in the affirmative. Take the position of this ship first; she would have been utterly unable, as I think I have conclusively shown, to have opened her main-deck ports to fire, unless placed head on to the sea. Her broadside guns train rather more than two points before and abaft the beam, and they are supported on the upper deck by two guns, one on the quarter deck and one on the forecastle, training respectively about 19 degrees before and abaft the beam. It follows, therefore, that if a turret-ship had taken up a position in either bow or quarter of this ship, there would have been a radius of four or five points on either bow or quarter, which would be points of impunity, or she would at the worst only have to contend with one gun. I enclose a diagram which will illustrate my meaning. But further, suppose the turret-ship chose or was obliged to take up a position where the broadside guns of this ship would bear on her when they could be fired, the result would be that the main deck of this ship and the upper deck of the turret would be both flooded alike; but the advantage would, as I think, still remain with the latter. The sea might, and probably would, wash right over the deck of the turret ship, but the water *would be got rid of, whilst here it is not at all clear that it could be got rid of, and certainly not as fast as it would accumulate.*"

Thus say two most distinguished officers, and can anything be more conclusive or corroborative of what I have from time to time stated!

I must first call attention to the fact that, except the *four* 12-ton guns carried by the little "Wyvern," there were only *two* afloat in that squadron; these were on board the "Bellerophon," of 4,000 tons, which, with two ports open, could only manage to fire *two* rounds out of the *fifteen* ordered, and even then, Admiral Yelverton says, "ship-"ping a good deal of water, to the destruction of some of the cartridges "in the guns."

What would have been the result had she opened all her large ports of that area (see Fig. 11), truly, as Admiral Warden says, "the men "would have been *washed* from the guns."

In 1863 I illustrated this awkward position by that diagram, when some of the anti-turret party said it was not a fair illustration; but these reports have proved it only too true. It has been published through various sources, as a set off against the advantages of the turret system, that the broadside could fire *two* rounds to the turret's *one*. I, on the contrary, have always asserted that the broadside could not fight heavy guns efficiently, but that the turret, instead of the broadside, would have the advantage both of quickness and precision in firing.

In consequence of what took place last year, I have been precluded from answering this alleged superiority of the broadside system, and I consoled myself with the old adage "Truth must prevail," which has now come to my rescue. For we find by Admiral Warden's report that the "Lord Clyde," with only 6½-ton guns, fired 15 rounds from

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five guns in 45 minutes, or three rounds at the rate of one round in 15 minutes, whilst head to sea, with a roll which did not "exceed 10 or 11 degrees."

The "Royal Sovereign," with defective wooden carriages, fired, according to Captain Key's report of November 7th, 1865, 10 rounds from her two guns in the foremost double turret at the rate of 2 minutes 35 seconds per round, with a maximum roll of from 13 to 15 degrees; and that same day fired 74 rounds with ease at the rate of 2 minutes 16 seconds per round, without mishap; and although the sea came upon her deck, not a bucketful of water came into the turret.

Gentlemen, this is a triumph I must be excused for exulting in, and for taking this opportunity of contradicting the erroneous statements made against fighting turret guns.

Admiral Yelverton says:—

"The turret system of arming a ship would have had a great triumph on this occasion, for there is no doubt that a sea-going turret ship, say 12 or 14 feet out of water, would have fought her guns without the slightest difficulty, and have fired easily six shot to every one from our broadside ships."

The remarks of the Controller on the reports of these sea-going Admirals, deserve notice. They argue in favour of this broadside fleet, and conclude by trying to disparage the advantages which the Admirals consider a *good* turret ship would have. The Controller says, "the sea-going turret-ship has shown as much disposition as her "broadside consorts to roll;" but this remark must be taken with the correction, that no sea-going turret-ship was in company with them, or even possessed by the *British Navy*.

The Controller admits this, for he says:—

"The reports of Admirals Yelverton and Warden confirm, in a marked manner, those, I have from time to time made previous to and since the purchase of the 'Scorpion' and 'Wyvern,' that these ships were totally unfit for cruizing ships."

My published correspondence with the Admiralty in November, 1864, and again in 1865, will show that these vessels were never intended for sea-going cruisers, for I wrote as follows:—

"With reference to the approaching trials of the 'Scorpion' and 'Wyvern,' assisting in the elucidation of these difficulties, I must beg you to remind their Lordships, that I am in no way responsible for those vessels, and would call their attention to the following copy of a letter, dated November 24th, 1864:—

"My dear Lord Clarence Paget,

"The impression from the public journals appears to be gaining ground, that the Birkenhead rams may be considered sea-going turret-ships on my principle; as when I last saw you I pointed out that they do not represent my views, it is hardly necessary for me to do so now; still, as, since they were brought into our service, I have assisted in some points in adapting them to our Navy, I wish you to distinctly understand that the applications of my turret system to sea-going ships can in no way be judged of by the performances of these vessels, for it must be remembered that they have been locked up many months, a long time, in the rapid strides of a new-born invention, and I feel confident Messrs. Laird Brothers would bear me out in saying, that if they were asked to design a sea-going turret ship for the ocean work of our navy she would be a very different description of vessel. These vessels are 1,900 tons, and carry four heavy 12-ton guns on 16 feet draught of water, while

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the 'Royal Sovereign' is 3,900 tons, and carries only one gun more on a draught of 26 feet of water.

"The power of carrying such heavy guns into action on so light a draught of water renders these vessels very valuable for an enemy's coast, where light draught of water is essential; but it can hardly be expected that they should be as well adapted for ocean cruising as vessels of larger tonnage and heavier draught of water, in proportion to their armament, if especially designed for this service.

"I am, my Lord,

"Yours faithfully,

"COWPER P. COLES.

"The Right Hon. Lord Clarence Paget,
&c. &c. &c."

"Those vessels were brought into the service for political purposes, and since their purchase, even some most important suggestions made by me for the comfort of the crew, have not been allowed to be carried out. I, therefore, must respectfully protest against those vessels in any way being used, to put off building a sea-going ship, or as an argument against the adaptation of the central armament system to cruisers for our Navy."

After their first cruise, in 1865, from further suggestions made by *their Captains*, I sent in drawings, showing how the poop and forecastle should be connected by a spar or hurricane deck, 13 feet out of the water, on the same principle as those of the Cunard packets, which cross the Atlantic in all seasons, and such as I have described for the "Captain," now building.

These diagrams (Fig. 14, plate xxxvi) are taken from the explanatory drawings enclosed in my letter of November 29th, 1865, in which I said:

"I have thought it right to point out to their Lordships, that these suggestions, made by those officers, will be of the greatest value for sea-going turret-ships."

I must ask you, Gentlemen, to look at these drawings, and hope they will be sufficiently explanatory. I found, however, a year afterwards, from the correspondence presented to the House of Commons, that the Controller's report on my letter and drawing was as follows:—

"Considering the vague terms of Captain Coles's letter and other circumstances to which I have called their Lordships' attention. I do not see that anything else can be done than to acknowledge the receipt of it with thanks, which accordingly I beg leave to submit be done."

Up to this day these improvements have not been made; had they been, these vessels would have been as comfortable at sea as any broadside ironclad of their tonnage, and able to work their guns when these ships could not.

At the same time every improvement and addition (including upper decks) which could be suggested, or which money could procure, have been made to the "Bellerophon," "Pallas," and "Research."

The "Wyvern" was the only vessel carrying a complete armament of 12-ton guns, and her cruising with a squadron of large vessels in the Atlantic in this incomplete state, can only be compared to sending a broadside ironclad to sea without the means of closing her ports. If the "Scorpion" and "Wyvern" when bought into our Navy in 1864 were thought when improved, to be capable of giving the system a fair trial, it would seem obvious that they should at once have been improved and fairly tried. If they were not thought so capable, it would seem

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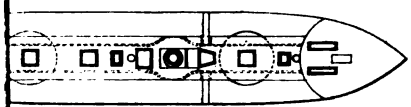
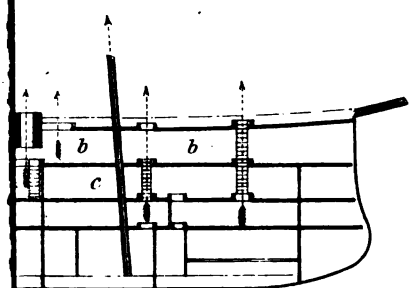
WYVERN
HURRICANE DECK ADDED.





J. Gibbins

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equally obvious that other vessels should have been at once built which *were* capable of affording such a trial. Neither of these courses was taken, but it has happened that vessels of even less tonnage than the "Wyvern," designed by Messrs. Laird, carrying 300-pounders, have crossed the Atlantic, rounded Cape Horn, and proved a great success.

Even looking at the designs that have been from time to time submitted to the Admiralty, the one made by Mr. Barnaby in 1863, on the plan of No. 4, or had any one of the vessels proposed by me been built, we should have had a sea-going ship to compare with, and the information thus gained would have saved millions to the country.

As it is, the little "Wyvern," without the requisite additions, has been used to disparage the favourable conclusions as to the turret system arrived at by both Admirals.

Having thus heard these practical seaman's reports, who will concur in the remark, that these broadside ships "have satisfactorily fulfilled "the purpose for which they were intended?"

It is worthy of notice, too, that whenever there was a head-swell, these shorter ships, with a plough-bow, lost their speed, and when at full speed, with a "*head-swell*," the "Bellerophon" made only 11 knots against the "Achilles'" 13·4 knots, confirming my condemnation of these bows, and the bad proportion of breadth to length in these ships.

The Controller says:—

"Again, except in the turret-ships designed by the Admiralty (designs not approved by the inventor) the nearness of the gun to the water has an important bearing on the probability of striking the object fired at, as the undulations of the sea, even when the ship is rapidly flying past the vertical position, must often completely interpose between the gun and the object aimed at."

I do not know what turret-ship, designed by the Admiralty, is alluded to, unless it is the "Monarch." But, so far as my information extends, she is a burlesque on the turret-system, her guns being 17 feet out of water, with high and weak sides; and I see by the papers that she is fast turning into a square box-ship.

As a rule I have placed the guns in turret-ships, the same height out of water as in broadside ships; the difference being that the turret-gun, being near the centre of the vessel, is further from the water. The "Royal Sovereign's" guns are 12 feet out of water; "Naughty Child's" 10 feet, turret-ship, designed 1863, 13 feet; one turret-ship in 1865, 13 feet; "Captain," building, 11 ft. 6 in., which at once dispels this delusion.

The Controller again says:—

"The conclusion I should draw from these remarks would not be that there is no advantage whatever in a well-designed turret-ship carrying her guns high out of the water under circumstances of heavy rolling, if she were put into a good position in an encounter with a broadside ship, but that these advantages, in such turret-ships as we are acquainted with, are not altogether so great or so decisive as they might appear at first sight."

Again, I say, it is a misfortune that we had no good sea-going turret-ship of any size to try on this occasion. As it is, the evidence

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of the Admiral's reports is highly condemnatory of these broadside ships, but strongly in favour of the turret system.

The Controller adds:—

"It seems to me a sound conclusion to draw from these reports, that a naval engagement with ironclads will seldom be attempted, unless in a moderate sea."

I must confess, that I think it may be necessary for a broadside fleet to decline an engagement, except in a moderate sea, but they may not be able to do so: and even in smooth water the aim will be more accurate; the *diminution* of *target* with thicker plating in a turret-ship; the less impediment of *smoke* hanging over and the *greater danger* to a broadside vessel of having her ports fired into with shell; or her thinner side perforated; will give decisive advantages to the turret-ship.

The Controller thus advocates his broadside guns as gallantly as he would fight them if he were in command, but when he is forced by the Admiral's reports to rely on the argument that Naval actions will only be fought *in a moderate sea*, surely it may be said in all good humour that he is reduced to his last cartridge!

It is rumoured, though I do not vouch for it, that when the sea was coming in at the ports of the "Lord Clyde," as I prophesied it would in this room in 1863, the Admiral was on the main deck, and did actually swim for a hatchway! How fortunate it was that it was not our gallant friend the Controller. He, I am convinced, would have stuck to his broadside guns even in that dire extremity! He would have *disdained* the hatchway, and *might* have perished in the waters!

Since these latest specimens of broadside ships have proved themselves so deficient in speed, it shows that the new theory of greater beam in proportion to length is wrong, and that the old and experienced Naval Architect, who designed the "Warrior" and "Achilles," was right. One point I am sure all will agree in, viz., that whatever merits may be possessed by these ships, if they cannot fight their guns, and would be at the mercy of a "*good turret-ship*," they are practically valueless.

Our broadside ironclad fleet has now been built at an enormous cost, and must of course be used, but it is now a very safe prophecy to make, that in a very short time they will be absolutely useless for fighting purposes. If it be true, that waterproof cartridges have now been ordered for the use of these heavy guns in broadside ships, it reminds me of the argument in favour of the old *flint lock*, namely, that you could make a waterproof cover for it. But woe to the country whose fleets have to resort to such measures to try and "*keep their powder dry.*"

In looking back to the development of iron-clads and artillery since 1855, it will be observed that the broadside partisans, whilst avoiding the true principle of the turret system, have so far acknowledged the advantages in imitating its fighting powers by poking guns out of broadside ships in all directions, which only complicate their difficulties.

It now remains to consider what is the best type of vessels for our Navy.

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My friends may say that I have too many patterns; but I am like a shoemaker, who can make any pattern for special purposes, from a dancing shoe to a waterproof shooting-boot, but sticks to his leather. *Mine is the turret.* I maintain that as a rule, special vessels must be built for special purposes where armour is involved, but that the turntable and shield, which, combined, form my turrets, admit of the construction of war ships, which can serve more general purposes than those built on the broadside principle. For instance, vessels capable of the defence of our shores or colonies, fit for the close attack of an enemy's strongholds; carrying the heaviest cannon that can be manufactured, and yet capable of crossing the widest oceans; can only be found to-day in existing vessels with a low freeboard and turrets. With reference to sea-going cruisers that can house their crews comfortably for long voyages under steam or sail, I point to Fig. 6. The "Huascar" class, from 1,100 up to 1,500 tons, with one or two turrets, working up to the largest class, the "Captain's" size of 4,000 tons (Fig. 7). These vessels will meet every necessity for the comfort of the most luxurious sailors, are seaworthy, and are well adapted to the ordnance of the present day. But as heavy ordnance becomes more general, we must go still further, and come to all sizes of vessels, like Figs. 8 and 9, with 10 or 15 inches of armour, such as are to-day constructed in America. But I hold, and so I presume will all sailors, that a pennyworth of practice is worth any amount of theory on such a subject as the sea-going qualities of vessels with low freeboard. The nation which has put the turret principle to the proof on that head, as well as its fighting powers, declares emphatically in its favour on both points. The following are the words of the American Secretary of the Navy, in his report, dated December, 1866. Alluding to the turreted ships, he says:—

"The impression sought to be created, that these vessels could not venture outside the harbours where they were constructed, or at all events that they could not proceed on a distant voyage, has been dispelled by the cruise of the 'Monadnuck,' which after navigating the Atlantic and Pacific, reached San Francisco in safety. The 'Miantonomoh' has crossed the Atlantic and has traversed the Baltic and Mediterranean. *These vessels have in these two voyages disposed in a great degree of the misrepresentations and prejudices which have been created, and proved the ability of the turreted vessels to perform long voyages when required.*"

The "Monadnuck," in June last, is reported by Admiral Rogers to have been in a very heavy gale, he gives the height of his eye above the level, as well as that of her mast-head light, from which I glean that the storm waves were about 25 feet in height, and he says:—

"In this sea, according to the testimony of her officers, she was very easy while it blew the hardest and the sea was most violent, she twice parted her tiller-ropes in quick succession."

Yet by the aid of her twin screws the ship made excellent weather lying to.

It may justly occur to you all, how is it that the inventor of the turret system has to-day to quote American evidence on the sea-going capacity of vessels fitted on his principle. All I can reply is, that the fault is not mine. It will be two years more before the first sea-going

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vessel constructed according to my views will be ready, for I cannot accept the "Monarch" as a fighting turret-ship. Am I unreasonable if I say that, apart from the "Captain," other turret-ships of a smaller class ought to be laid down to test my principle, as against the small class of broadside ships in the character of cruisers. For I cannot too earnestly impress upon you, that I make the fullest distinction between a cruiser, and a vessel merely capable of making a long sea voyage. The cruiser is a ship capable of keeping her crew in health and comfort on the high seas, possessing good steam power but trusting much to her sails.

The other vessels, Fig. 8 or 9, with a very low freeboard, have yet to be tested by our Navy. The "Royal Sovereign" and "Prince Albert" do not illustrate the advantages of the system of a minimum freeboard, and apart from the "Captain," I have been given no opportunities of acquiring by experience and practical tests, proofs of the advantages or defects of these two smaller classes of turreted ships. As an inventor, I may be supposed to be prejudiced, but this I can assure you that what I desire is, to see my inventions put to the severest practical tests, in order, that defects may shew themselves, and I may set to work to remedy them. A fleet of broadside ships have been constructed, with unlimited expenditure, on all possible devices, and the advocates of that system have had vast opportunities of correcting, adding to, and taking away from their original productions, whilst I, as a Naval Officer, have to work it out or trust to the evidence of foreign sailors, that evidence being pooh-poohed in many cases by my countrymen.

Passing from armoured turret-ships, I hold that we must also possess numerous swift unarmoured ships, with heavy guns on turn-tables, for the protection of our commerce, &c.; but all such ships should be built of iron, for every wooden ship is so much money wasted. The armour or the shield may not always be necessary, but the turn-table is, whenever guns of 12 or 20 tons have to be fought efficiently in a sea-way. My opinions as to the value of our wooden line-of-battle ships, recorded in the theatre of this Institution, in 1860, and illustrated by Fig. 15 (Plate xxxvi), have been more than realised, for they are to-day being sold, engines included, for £2 16*s.* per ton, they having cost £25 per ton. I also then pointed out that to plate the large surface necessary to protect broadside guns, with numerous port-holes for the ready entry of shot, shell, and water, would be abortive. What I then said of the wooden line-of-battle ships, I now say of armoured vessels, with their guns ranged along their sides (see Fig. 16); and do you not think, with the evidence before us, that I am justified in my opinion?

Touching the future of the turret system, I am not without hope that its worst days are over. In the first place the Admiralty is now under a rule combining practical knowledge with absence of professional prejudice. I have noticed, since the very remarkable experience of our fleet and that of the French last autumn, that without quite coming round to turrets, there is a disposition to accept the principle, provided some clever men can find a way of doing so without laying

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themselves open to the charge of wasting the public funds for the last seven years. The latest thing I have heard of is a semi-turret ship, with high freeboard, and this, I suppose, I ought to accept as evidence of at least a semi-conversion to the principle.

In conclusion it is obvious, I believe, that by lowering the free board to the minimum, the following advantages are obtained, viz.:—

1st. A steadier gun platform, and incidentally less risk of being struck below plating whilst rolling in a seaway, as well as the power of fighting these heavy guns in a seaway.

2nd. Diminution of area to be plated makes smaller vessels and thicker plates practically available.

3rd. Diminution of target and increased thickness of plates both incident to lowering the free board, seem the only effectual means of resisting the advances of modern guns and projectiles.

4th. Less expense in the first outlay to produce these costly ships, since less tonnage is required, and fewer men, making it practicable to man more ships in time of war.

The disadvantages often alleged to be incidental to a low free board, viz., discomfort to the ship's company, is obviated in vessels of every class by means of a hurricane deck, such as I have described in figs. 6, 7, 8, and 9. I would also observe that the recent improvements in guns and projectiles have increased the risk, previously very great to vessels with high free-board and central casemated batteries, from the entering of the shell, either through their large ports, or through their weak sides, and this is a risk which there is no means of obviating in broadside ships.

Disregarding for the moment all other considerations than the comfort of the ship's company, it still seems questionable whether any increased comfort in time of peace from a high free board, is not more than counter-balanced by their greatly increased weakness from the cause I have mentioned, in time of war.

I cannot conclude without endeavouring to express my gratitude to those who have held out the hand of friendship to me throughout such an up-hill struggle.

Allow me to thank you, Ladies and Gentlemen, for your kind and patient hearing through, I fear, a somewhat tedious paper; and it is with great pleasure that I see so many distinguished persons among my audience, but more especially the faces of some fair ladies.

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APPENDIX.

Comparison between "Bellerophon," "Captain," and "Warrior."

	"Bellerophon."	"Captain."	"Warrior."	
Length	300 feet	320 feet	380 feet	
Beam	56 ft. 1 in.	53 feet	58 ft. 4 in.	
Draught of water	26 ft. 6 in.	23 feet	27 ft. 3 in.	
Tonnage	4270	4272	6109	
Horse-power	1000	900	1250	
Speed	14	14¼	14	
Iron plating on deck	⅝	1½	⅝	
Whether wholly or partially clad	Partially	Wholly	Partially	
Maximum thickness of armour plating on ship's side	6 in.	8 in.	4½ in.	
Ditto on battery or turret	6 in.	10 in.	4½ in.	
Inner skin	1½ in.	1½	9/16 in.	
Height of spar on hurricane deck above water	14 feet	19	17	
Ditto of guns above water	11 feet	11½	10 ft. 7 in.	
Distance of guns horizontally from the sea	0	12	0	
Calibre of guns	300-prs.	600-prs.	100-prs.	
Weight of broadside from guns protected by armour in turrets or battery	1500	2400	1300	
No. of officers and men	556	400	705	In the Navy Estimates of 1865 Lord C. Paget states that the average cost per head of officers and men is £74 5*s.* 3½*d.* a-year; so, as the "Captain" has 156 men less than "Bellerophon," in this item she will cost the country £11,585 2*s.* 3*d.* less per year.
Cost up to July, 1866, as per Parliamentary return (No. 526)	*a.* £430,495	*b.* £335,000*	*c.* £360,995	*This leaves a margin in favour of "Captain" over "Bellerophon" at present of £95,495.

a. This includes share of dockyard, but not armament and other fittings, as accounts are not yet completed; see Parliamentary Return (526).

b. Messrs. Laird's tender for "Captain."

c. It is now admitted that "Bellerophon's" guns are too close. She ought not to have more than four guns of a side in her battery, making her effective broadside only 1,200 lbs., or one-half that of the "Captain's."

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COMPARISON BETWEEN "ROYAL SOVEREIGN" AND "PRINCE ALBERT," AS THEY ARE AND AS THEY SHOULD HAVE BEEN.

"ROYAL SOVEREIGN."

As she is with 3 *Single and* 1 *Double Turret, and* 5 *Guns.*

	tons.	cwt.	qrs.	lbs.
After-turret	148	13	0	4
„ next	151	7	1	14
„ next	151	0	3	0
Double „	163	0	3	10
Five guns with carriages (each 14 tons 8 cwt.)	72	0	0	0
	685	2	0	0

The above weights comprise glacis plates, beds, pivots, pillars, and everything appertaining to the turrets.

As she should have been with 3 *Double Turrets and* 6 *Guns.*

	tons.	cwt.	qrs.	lbs.
Three double turrets (each 162 tons 0 cwt. 3 qrs. 10 lbs.)	486	2	2	2
Six guns with carriages (each 14 tons 8 cwt.)	86	8	0	0
Balance of weight to spare	112	11	1	26
	685	2	0	0

"PRINCE ALBERT."

As she is with 4 *Single Turrets and* 4 *Guns.*

	tons.	cwt.	qrs.	lbs.
Four single turrets (at 140 tons each)	560	0	0	0
Four guns with carriages (each 14 ton 8 cwt.)	57	12	0	0
	617	12	0	0

As she should have been with 3 *Double Turrets.*

	tons.	cwt.	qrs.	lbs.
Three double turrets (each 162 tons 0 cwt. 3 qrs. 10 lbs.)	486	2	2	2
Six guns and carriages (each 14 tons. 8 cwt.)	86	8	0	0
Balance of weight to spare	45	1	1	16
	617	12	0	0

Showing that the "Royal Sovereign" would have one more gun, with 112 tons to spare, and the "Prince Albert" two more guns, with 45 tons to spare, which, in both cases, would have given increased room and accommodation.

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DESIGNS OF TURRET SHIPS SUBMITTED TO THE ADMIRALTY.

	1. Designed by Controller. "Prince Albert."	2. Drawn out with Mr. Barnaby in Controller's Office.	3. "Naughty Child."	4. Drawn out with Mr. Scullard at Portsmouth.
Date	April, 1862	March, 1863	April 14, 1863	April 3, 1865
Length	240 feet	280 feet	225 feet	225 feet
Breadth	48 feet	54 feet	46 feet	49 feet
Draught of water	20 feet	24 ft. 6 in.	21 ft. 7 in.	22 ft. 6 in.
Tonnage	2,529 tons	3,700 tons	2094 tons	2,409
Horse-power	500	800	400	600
Speed	11	12½	10-8	13-8
Thickness of armour-plating on ships	5½	4½	4½	6
Height of guns out of water	12	13 ft. 6 in.	10 ft. 6 in.	13
Number of turrets	4	4	2	1
Armament as originally designed	12 100-prs.	4 300-prs.	3 300-prs.	2 600-prs.
Ditto as decided	4 300-prs.	,,	,,	,,
Weight of broadside as originally designed	1,200 lbs.	1,200 lbs.	900 lbs.	1,200 lbs.
Ditto as decided	,,	,,	,,	,,
Area of sails in square feet		33,000	20,000	26,620
Whether sea-going or coast defence	Coast	Sea	Sea	Sea
Whether built	Yes	Never	Never	Never

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TURRET-SHIPS IN EUROPE ON CAPTAIN COWPER COLES'S PLAN.

Built.	Weight of one broadside protected by armour.	Tonnage.	No. of Men.	Designed and built by
	lbs.			
1. Rolfe Krake.....	272	1246	100	Messrs. Napier (Glasgow).
2. Royal Sovereign	1500	3765	300	Conversion.
3. Scorpion	1200	1833	170	Messrs. Laird Brothers.
4. Wyvern	1200	1833	170	Ditto.
5. Smertch.....	600	1350	100	Messrs. Mitchell.
6. Armenius.....	288	1230	99	Messrs. Samuda.
7. Affondatore.....	600	2306	188	Millwall Iron-works.
8. Huascar	600	1100	83	Messrs. Laird Brothers.
9. Minerva.....	300	1000	80	Ditto.
10. Bellona.....	600	1330	100	Ditto.
11. Prins Hendrick	1200	2096	200	Ditto.
12. Prince Albert.....	1200	2537	200	Admiralty.
	9560	21626	1790	
Building.				
13. Monarch.....	2400	5100	500	Designed by Admiralty; objected to by Capt. C. Coles.
14. Captain	2400	4272	400	Messrs. Laird Brothers and Captain Cowper Coles.
15. Russian—Charadaca.	1200	1626	136	Russian Government. 2 turrets 4 guns.
16. Ditto Rousalka..	1200	1626	136	Ditto. 2 turrets 4 guns.
17. Ditto Minerve ..	1800	2170	180	Ditto. 2 „ 4 „
18. Ditto Admiral Chickakoff	1800	2170	180	Ditto. 3 „ 6 „
19. Russian — Admiral Speredof.....	1800	2170	180	Ditto. 3 „ 6 „
20. Russian — Admiral Greg	1800	2170	180	Ditto. 3 „ 6 „
	14400	21304	1892	

* There are several now building in France.

The CHAIRMAN: It will be quite impossible to discuss this very important and instructive lecture at this late hour. We propose to adjourn the meeting to to-morrow night. But as the discussion will occupy some time, the meeting will commence at eight, instead of half-past. However, as there is a large number of gentlemen present, it would be only fair to the "anti-turret party," if I may use that designation, to give them an opportunity of speaking to the point, although it must necessarily be very short. Mr. Reed will, perhaps, address the meeting.

Mr. E. J. REED, Chief Constructor of the Navy: Mr. Chairman, I am sorry to have to respond to that invitation, and to speak under that form of invitation.

The CHAIRMAN: I apologise for having used the expression.

Mr. REED: I am quite sure that it was spoken conversationally and conventionally.

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But I mention it because I think it would be highly improper and in the worst taste for any official person whatever to present himself as an opponent of the turret system. I think I may appeal to Captain Coles to say—if I am considered by himself or by any other gentleman as an opponent of the turret system—that I have not always been so; because it was my good fortune very early to be associated with Captain Coles in claiming public consideration for his invention; and Captain Coles has done me the honour, sometimes with my assent, sometimes without it, to quote remarks of mine in connection with that aspect of the subject, as a supporter of the turret system. I think it is only due to myself to say under the peculiar circumstances of the moment —not of the case—of the moment only, that I have always been a great advocate of the turret system; and that which I have always longed to hear and to see in connection with the turret system is that which I have not been privileged to see and hear on this occasion, namely, a thoroughly impartial advocacy of that system—a setting forth of that system upon grounds which ought to affect and can affect official persons entrusted with the responsibility of building the Navy of England. And I must say that I very much deplore, indeed, that it has been the ill-fate of the turret system from the first to be associated with representations which are not substantiated by fact, but which are attributable to undue enthusiasm on the part of its very able and very honourable advocate. Now, I should only like to refer, as a preliminary indication of his not exceedingly fair method, to that dark gentleman looking through the broadside port. I ask any gentleman, presuming the port to be 4 feet high—and Captain Coles tells us it is—whether that is a man of reasonable stature? My impression is that he is not a fair representative of the British seaman; because from the top of his hat to the soles of his feet he only measures about 4 feet in height. Another more serious departure from what is artistical accuracy, is to be found in the frequent representations put forward this evening touching Her Majesty's ships. Permit me to say here—what I have not had the opportunity of saying before, viz., a few words with regard to the trial of the "Bellerophon," which has been put forward two or three times this evening, and certainly two or three dozen times before by the supporters of the turret system. The report of that unfortunate trial of the "Bellerophon" Captain Coles holds in his hand. It shows that the indicated horse power on that occasion—the first time her own stokers tried to produce a full speed trial—was 4,000 horse-power. Now, I never bargained that the full speed of the "Bellerophon" should be 14 knots, with 4,000 horse power, but with 6,000 horse power. I say you cannot take that as a true test, when the trial was made with one-third less horse-power than the vessel was intended to employ. I am sure I need not, in a meeting like this, of gentlemen who are eminent as naval officers, and many of them eminent at the same time for their capabilities in reference to steam, say that it is not an easy thing in a ship with surface condensers, and super-heaters, and a number of modern devices adopted for a very proper purpose, namely the economising of fuel—it is not fair to expect that her staff of stokers and engineers shall, on the first occasion when they are charged with the duty of obtaining full power, produce that full power. It is the fact, stated on the authority of the captain of the ship, that the ship did on the following day steam her 14 knots with the indicated horse-power which was bargained for. Permit me to say further—and I am very pleased indeed to have the opportunity of saying it in the presence of Captain Coles—that while he has been exceedingly free this evening in his censures on official persons on account of the great delay in building sea-going turret-ships, I am the very person who, two years ago, did advise Captain Coles to build a turret-ship, to accept an offer from the then Board of Admiralty, who offered to build him a ship on the dimensions of the "Bellerophon." Captain Coles then repudiated that idea, scouted it with no great expression of personal respect for myself. He did so on the ground that the ship was a great deal too large. Now, I want to know how it happens that, if two years ago a ship of certain dimensions was too large for Captain Coles's plan when designed by me, he should now accept a design a little larger by Messrs. Laird? Captain Coles will have to account for that circumstance. He will also have to give account for a more serious circumstance, bearing upon a point that he has not alluded to this evening, namely, how it happens, when he is so sensible of leaving ships exposed a very little way below an imaginary water

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line, that he has consented to build a ship which has only 5 feet of armour-plate below the water line? Notwithstanding his comparison between the "Captain" and the "Bellerophon," which was a one-sided comparison, in which he left out many considerations, I must say he utterly failed to convey to you why, seeing that the "Bellerophon," built three or four years ago, has her armour extending 6 feet 6 inches below the water—why this vaunted "Captain," which is now building, is to have her armour 5 feet below the water line only, and a single inch thicker only than in the "Bellerophon" in the wake of her engines and boilers. My own conviction is—and I speak it with the greatest possible regard to those many official considerations which weigh upon the minds of the gentlemen who constitute Boards of Admiralty —I say my own feeling is, that it is our duty to make progress, and not to go back; and yet Captain Coles, who has pointed out the importance of the armour being carried low down, has himself consented to accept a design in which the armour descends 5 feet only below the water line, in a ship of more than 4,000 tons. Another point which I should like to refer to is in connection with the cost of the "Bellerophon." I feel placed at a disadvantage in this matter, not so much by Captain Coles, as by a singular, a strange, and a sad conjunction between what I believe to be an excessive Parliamentary activity on the details of ship-building, and an unfortunate yielding of Admiralties to pressure of that nature. The sum which Captain Coles has quoted as the difference between the cost price of the "Captain" and the "Bellerophon," amounting to nearly £100,000, happens to include an item of over £90,000, which does not belong to the "Bellerophon" at all, any more than it does to any other ship constructed in the dockyards. It is a perfectly abstract sum, based upon the cost of our dockyard establishments, and yet that £100,000 has been charged to the cost of the "Bellerophon." I must say it does sound strangely in my ears, when I know that the "Captain" is to cost precisely the same as the "Bellerophon," or very nearly so, and when we know, moreover, that there is some reason to conjecture that the price of the "Captain" has been based upon the price of the "Bellerophon," to hear it said that the one ship cost £100,000 more than the other, because of an arbitrary matter of account which does not enter into the cost of the vessel at all.

The CHAIRMAN: Is not this the charge on the plant, that is added, and which is charged for of course in Mr. Laird's account?

Mr. REED: Permit me to say that the £100,000 includes the cost of chaplains and a thousand other things, which I am not responsible for. It is admitted to be, by persons conversant with the subject, a very arbitrary and a very unfair charge against the cost of the ship.

The CHAIRMAN: This is the plant, and the dockyard expenses. Mr. Laird must pay for his officers who superintend his work, or it would cost more.

Mr. REED: My contention is that the sum is perfectly arbitrary and very excessive. That is my point; the sum included in Captain Coles's figures, is 35 per cent. upon the total cost of materials and labour. There may be gentlemen here who concur in the justice of that charge. I do not myself, and I may be permitted to express my dissent from it. Again, it is a singular circumstance to my mind that Captain Coles should, somehow or other, whether by a clearer insight than I can possibly attain to, or by some other gift, I do not know; but he certainly has the singular capacity of seeing enormous merit in the low free-board of a turret ship at one moment, and yet fails to see altogether the deplorable disadvantages of that low free-board, which are not less evident. Captain Coles has read to you a series of extracts from the reports of the Admirals who commanded the Channel squadron. And Captain Coles has singularly enough quoted a fact, reference to which involves, I believe, some oversight on the part of one of those gallant officers, inasmuch as it is put as a very strong point against the "Bellerophon," that she only fired two shots when the ships were ordered to fire fifteen. Now, the report itself distinctly states that five guns were cast adrift on one of the broadsides, and they fired three shots each. The "Bellerophon" only fired two shots altogether. Why? Because the "Bellerophon" had only one gun on each side! And Captain Coles knows the fact, because he told us later on in another connection, that the "Bellerophon" was the only ship that carried the twelve-ton gun in that squadron. I have

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not re-read this report with the care which such important documents deserve; but my impression is, that that fact, that the "Bellerophon" had only one gun on each side was—

Captain SCOTT: I will explain that at the next meeting.

Mr. REED: You will agree with me that it was no serious thing, when the other ships fired three shots per gun, that the "Bellerophon" should only fire two shots with one gun. But what I want to draw attention to is, that Captain Coles has read three paragraphs from Admiral Yelverton's report. He has read a certain paragraph, and he has read a certain sentence which precedes another sentence, and he has read another paragraph and another sentence which succeed that other sentence. But the sentence itself has escaped the notice of Captain Coles. Perhaps you will not be at a loss to discover the cause of it when I read it. It relates to the rolling of the ships, when no wooden frigate would have thought of fighting her guns at the time; and Admiral Yelverton says:—"I do not allude to the 'Wivern,' "for the sea would have washed into the ports of her turret, and swamped every-"thing inside." Now, if the object of Captain Coles, or the object of any other gentleman, be to produce a momentary or temporary impression in favour of an invention or plan, then I contend that there is no reasonable objection to offer to this system of quotation, because it is one with which we are too familiar, which is very common, and which is I presume justifiable on the ground of its being so universal. But if it be the object of Captain Coles to impress the value of his system upon persons who are responsible for the adoption of it, and if it be, as I really think it ought to be, in justice to his own plan, his business seriously, measuredly, and guardedly to represent the merits and the demerits of his system, to seek to get it adopted upon its merits (for that it has many merits I am one of the foremost persons to admit), then I say that that style of writing papers ought to be amended, if he will excuse me for making the remark. I have here a series of notes which I have taken during the reading of Captain Coles's paper, which are almost—I really am sorry to make such an observation—which are almost beneath serious consideration. Of such a character is the remark upon the coal-carrying power of the "Captain" and of the "Bellerophon." The "Captain" carrying a given quantity of coal, and the "Bellerophon," carrying a given quantity, we are told that if you put 490 tons more, as you can, between the decks, the "Captain" can carry so much more,—Captain Coles never mentioning that you can put 490 tons more on the "Bellerophon," which she is perfectly capable, and far better capable, of carrying between her decks than the other ship. I do not consider it necessary at this late hour to occupy the time of the meeting by dwelling upon the points that I have noted down. But I am in a position to say this—I am very desirous, and am pleased to have the opportunity of saying this—that it is a great delusion and a great mistake to suppose that there is any interest, on the part of any person in any degree related to the official management of the Navy of this country, adverse to the adoption of the turret principle. I certainly have no such interest. I went to the Board of Admiralty with the complete design of the "Bellerophon" in my hand. I tendered that to the Board of Admiralty. And when some opposition was offered on the ground of the magnitude of the guns, I entreated that that ship might be built instead of another wooden ship, which had been sanctioned by Parliament to be plated with armour. The Admiralty yielded the point, and my ship was built, but I have never received a single sixpence for the design of the "Bellerophon;" and yet people speak of me as having an interest in opposing the turret system. I say it is too bad, when the sole reward and the sole emoluments have been all on one side, that in a question of this magnitude, official persons who have received nothing, should be put in the disadvantageous position of being represented as interested opponents of the turret principle. Now, I am not; I am an advocate for its adoption. I will go so far as to say that, if Captain Coles will do with me, personally, what he has done with Messrs. Laird—if he will acknowledge the inevitable conditions of the problem, and work with me on those conditions, I will co-operate with him; but if Captain Coles will demand of designers so much more than is possible, and if he will repudiate a design from myself, and then accept nearly the same design two years later from somebody else, then I say there is no rapid progress in store for the

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re-construction of the Royal Navy on his plan. Because, while I am an admirer of the Navy, I hope that all the gallantry does not belong to the Navy, but that a civilian may be considered to have some sense of integrity and some consciousness of the respect due to him and to his position. I will only trespass a short time further upon your notice. I will not say one word in defence of a gallant officer, under whom it has been my great privilege and pleasure to serve for several years—Admiral Robinson, the Controller of the Navy. It is not my duty to defend Admiral Robinson, and I will not attempt it. But I will beg the privilege of saying this, that Admiral Robinson is a very able and very zealous officer; that the criticisms which have been passed this evening are *ex parte* and irresponsible. When I say "irresponsible," I mean that they have not that responsibility which they would carry if they were intended to be a direct instigation to official action; they are irresponsible in that degree, and in that respect. Now I will only ask the gallant officers present, who are brother officers of Admiral Robinson, to bear in mind that they have, in him, an officer of great ability and great zeal; and *ex parte* statements with regard to him ought not to be received with derision on the part of any of the company present. I mention that because I observed an occasional smile at extracts from Admiral Robinson's report. I can only say it would be well for the country in the past, and for the country in the future, if all official persons were as capable and as zealous as Admiral Robinson has been. Now, permit me to express a last regret. I had hoped, when I came here this evening—and I may be permitted to say that Captain Coles was so kind as to set aside any little asperities which may have possibly been imagined to have existed in the past, and to favour me with a ticket in addition to that which I received from the Institution—I came here in the strong hope that we were about to hear for the first time a very impartial and a very careful statement of the merits of the turret principle, which are certainly due to its present position. Do not let officers suppose that I myself—and I am but a subordinate officer of the Admiralty, a civilian officer, and there are many gallant officers at the Admiralty above me, influencing me and controlling me—do not imagine that even I am insensible to the enormous value of being able to put a gun through a small port, and of being able to bring it to bear through a large arc on the enemy, or insensible to the many advantages pointed out by Captain Coles. But I am bound to be guided by facts; and I must say it is a most extraordinary thing that Captain Coles thought himself justified in putting a small ship like the "Wyvern" alongside a broadside ship, and telling you deliberately that 7° represented the rolling of the turret ship, and 20° represented the rolling of the broadside ship. The fact is, that the "Wyvern" is one of the very worst rollers in the squadron. The "Achilles" is a land battery, and the "Bellerophon" is a large approximation to a land fortification, as compared with that rolling structure the "Wyvern," which is continually under water. That I may not be supposed to be speaking without my book, I will simply say that that opinion is amply confirmed by the reports of the officers who commanded the squadron. It is the fact that the "Wyvern" was one of the very worst rollers in the whole squadron. I should like to say in your presence, Sir [to the Chairman, Captain Fishbourne], who have made the rolling of ships a scientific study for a long time, that it must be obvious that the rolling of ships does not exclusively depend upon the freeboard. As regards a height of two or three feet, I perfectly admit and know full well that the "Monitor" is the steadiest form of ship that you can possibly have. Inherently she is so. And although the "Achilles" rivals the "Miantonomoh" in steadiness, and is certainly not a turret ship, still I am prepared to admit that the turret-ship has advantages in that respect when the freeboard is so low as in the American monitors. But when you come to four or five feet in a small vessel, like the "Wyvern," you do not get the steady platform; you do not get that imaginary dry platform, so comfortable and so safe under all conditions; but you get a ship with the seas rolling over her and swamping the guns; in fact, a ship so bad, that Admiral Yelverton expressly says he does not condescend to mention her. As at the beginning, so at the end, I decline absolutely the position of being an opponent of the turret system. If my observations are taken in the spirit in which they are offered, I think I shall be taken by impartial persons to be as good a friend of the turret system as other persons. It is a piece of ancient philosophy that the friends who point

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out our faults are, after all, our best friends. I have always been and always shall be most anxious to co-operate with Captain Coles; and I think I am not an insubordinate officer of the Admiralty. I shall be only too proud to act under authority in endeavouring to bring this question to a proper bearing. I will only further say that Captain Coles very early in his paper used a remark which I object to. He spoke about the persons in office who resist the speedy adoption of his principles as the "anti-turret party." Now do pray remember that the late Admiralty did not invent broadside ships. Broadside ships have existed for ages. Captain Coles is the innovator, and it is the duty of the innovator to show that the old system is bad. He comes forward with a new invention, and because those in office have not so much confidence in it as he has himself, he calls them a "party." This, I think, is absurd. It is the too ardent advocates of turrets who form a "party," and they, not we, are partizans.

The discussion was then adjourned till the following evening at eight o'clock.

Adjourned Discussion.

Thursday Evening, May 2, 1867.

Captain FISHBOURNE, R.N., in the Chair.

The Chairman: I have no doubt you will think it desirable to confine the discussion as much as possible to the points raised in the paper, and I therefore propose that Captain Coles should read us the conclusions that he has come to.

Captain Coles read the following conclusions:—

"In conclusion, it is obvious, I believe, that by lowering the freeboard to the minimum, the following advantages are obtained, viz.:—

"1st. A steadier gun platform, and incidentally less risk of being struck below plating whilst rolling in a seaway, as well as the power of fighting these heavy guns in a seaway.

"2nd. Diminution of area to be plated makes smaller vessels and thicker plates practically available.

"3rd. Diminution of target and increased thickness of plates, both incident to lowering the free board, seem the only effectual means of resisting the advances of modern guns and projectiles.

"4th. Less expense in the first outlay to produce these costly ships, since less tonnage is required, and fewer men, making it practicable to man more ships in time of war.

"The disadvantages often alleged to be incidental to a low free board, viz., discomfort to the ship's company, is obviated in vessels of every class by means of a hurricane deck, such as I have described in figs. 6, 7, 8, and 9. I would also observe that the recent improvements in guns and projectiles have increased the risk, previously very great to vessels with high free board and central casemated batteries, from the entering of the shell, either through their large ports, or through their weak sides, and this is a risk which there is no means of obviating in broadside ships.

"Disregarding for the moment all other considerations than the comfort of the ship's company, it still seems questionable whether any increased comfort in time of peace from a high free board, is not more than counter-balanced by their greatly increased weakness from the cause I have mentioned, in time of war."

Captain Scott, R.N.: Mr. Chairman and Gentlemen, the lecture we have had is so important, that I think it necessary to follow the principal points *seriatim*, being as brief as possible on each; and, with that view, I will first remark that we all of course speak of what we are full of: "Out of the fulness of the heart the mouth speaketh." So Captain Coles speaks of his proposed turret-ships, and exhibits, as you see, eight

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or nine specimens. There is the "Captain," now building. But we must remember that the rapidity of improvement is very great indeed, and therefore the comparison between ships building with those not only built, but also in commission, is manifestly unfair. For a fair comparison we must compare each idea of the turret ship at a particular time with the broadside ship of the same time, or else we do not get the true comparison. The broadside ships are being developed day by day quite as much as the turret-ships are being developed. I think I shall be able to show that the whole principle of the broadside ships has been considerably improved. We must not be tied down to that comparison which, if Captain Coles will allow me to say so, he has so constantly made with broadside ships, and now makes of the "Achilles," a vessel built years since, and armed with 68-pounders, against turret ships armed with the heavy guns that are now carried. When these broadside vessels were designed, there was no such gun, therefore they could not be designed for what did not exist. In order to have a fair judgment on the subject, it is necessary to bear all these points clearly in mind. Now, of the Channel squadron the reports are seemingly unfavourable. You heard them read last night; the most unfavourable parts of them were read, but why were they unfavourable? because the guns were mounted on the obsolete plans of 1864 and 1865. We had gone into a new system of artillery, but we had stuck to our old carriages, tinkered up, it being probably thought they would be cheap, which they were, and very bad at the same time. Now, to show that this view is fully borne out, I have to revert to the opinions of the different Officers, and without saying that they are *verbatim*, I, as one of those who commanded a vessel during this time, and knowing well what passed in the vessels, hearing the opinion of each Captain, can give a tolerably clear idea—at any rate, I ought to be able to give you a clear idea—of their opinions. Now I find that the Captain of the "Hector" reports that the compressors were not to be depended upon, and that the train whips carried away, the compressor should hold the gun on recoil, and the train whip should run the gun in; so that the two principal things for working the guns were not to be depended on. The Captain of the "Achilles" also says the compressors were unreliable. The Captain of the "Lord Clyde" says that the running in and out gear is bad; there was no control over the guns. The Captain of the "Pallas" wishes pauls fitted to prevent the guns getting adrift. And as to the "Research," I have no hesitation in stating that her guns did get adrift, and I showed the reason. Can it be surprising that with the fittings I have just mentioned, those old fittings, and with such a tremendous swell as there was running at the time of the special trial, that the guns could not be fought satisfactorily? When has it ever been attempted to fire guns under similar circumstances? It must be remembered that the Admiral expressly states in his report that none of our wooden frigates would have thought of opening their ports in such weather; and here were those vessels laid purposely broadside to the swell, and attempts made to fire the guns with the old fittings, and therefore the result was not satisfactory. The explanation is as simple as possible. But to compare this weather, when the men could scarcely stand, with the weather in which the "Royal Sovereign" guns were tested, is absurd. She was merely tested in the Channel; and here were those broadside vessels rolling about in the very worst swell that could be found in the Atlantic. Now as to the "Bellerophon's" firing only two rounds, which have been very much dwelt upon, the "Bellerophon" went to sea before her gun carriages were ready. She had two guns on board; one of them was mounted on Armstrong's competitive carriage, which had competed with mine, and fired some sixty rounds; and the other was mounted on a wooden carriage, so weak that, after one or two rounds before the ship went out, they decided that it was unsafe to fire it any more; so that gun could not be fired. In the other case of the gun, its carriage had been taken out and restored, and then no person could adjust Armstrong's compressor. At the first round fired, the gun came in flying. The compressor was screwed up again, and the same thing happened. Nobody could adjust it, or perhaps from the effects of the competition its holding powers were gone. Whatever was the reason, the second time of its acting in that violent way, there being no power to control it, the Captain wisely determined not to fire again, but he says expressly he could have very easily fought his guns even at that time. I am sorry the Captain's

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reports are not printed, because he so decidedly says this. Now when, as I have shown, the Admiral speaks of guns badly mounted, it was what *was*, not what *is* at the present time. What *was* is simply this, that the ports were obliged to be opened to load the guns; what *is*, that we can lower our ports down in a sea-way, and load through the scuttles, and, with the training gear that is to be applied, this will be effected very easily, and these guns will be fired with great rapidity, far quicker than any firing in the turret, as I shall presently show. So that you see what Captain Coles so much insists upon, as to the powder being kept dry, is actually being carried out. The port is closed, there is simply a scuttle. Then, with the new fittings, the guns are run out rapidly. There will be no difficulty in training the guns, and elevating as they go out, and thus the guns can be kept bearing upon the object. The captain of the gun has plenty of space, and is enabled to see, and he fires when the gun is upon the object. Now, with reference to the size of ports: in the "Minotaur" the port was filled up, so that it was only 2 feet 9 inches deep, and 2 feet wide, and the gun then trained 30 degrees each way. There was no difficulty at all found in pointing, and the practice was exceedingly satisfactory. With the "Bellerophon" the lower part of the port was closed up, and narrowed to 2 feet 1 inch, and the gun trained 3½ degrees each way. This carriage is on board at the present time. Some Officers probably have seen it; at any rate they will be enabled to see it, if they wish. There is another reason why, as I said before, the ports can be closed up, as all that you want is sufficient height of gun to fire over the lower port cill you can use an elevating and depressing carriage. I shall presently show the advantage that it would give the broadside-ship, and then the gun goes closer out in the broadside than in the turret. There you see a diagram of the turret. I am not able to bring it in front, but you will at once see that in the turret the gun would be further out. Therefore for the same sized port, you would get less elevation and depression in the turret than you do with the broadside; and the turret's port will be found a very little smaller than the port was in the "Minotaur" when it was closed up in the manner I speak of. As to the gun's recoil, which Captain Coles thought to be limited to coming in six inches, I may inform him.

Captain COLES: I did not say coming in six inches. I said six inches inside the port.

Captain SCOTT: In the "Minotaur" the gun was allowed to come in 3 feet 6 inches. It came in 3 feet 6 inches clear of the side. That was found a great deal more than was necessary, so the gun on that carriage is now not allowed to come in more than 18 inches, clear of the port; and that gives a mean of about a foot, and there is not the slightest difficulty in loading. Now, as to seeing all round in the turret when that figure gets up and looks round, and sees a ship, it cannot be supposed, for one instant, that you are to depend on him, that is, on the captain of the gun for picking out his ship and firing at it. Why, in a general action, you would have one captain of a gun firing at a friendly vessel, and another captain firing at the enemy. It must be under the direction of the Officer of the quarters, who must be told in general terms where the vessels are, and to look out for those vessels. In fact, if a seaman exercises his individual ideas on the subject, you will have the greatest possible confusion. Therefore I think that remark as to the advantage of the captain of the turret gun, getting up and looking round, is really an imaginary advantage. I believe that the "Captain's" port, or the gun in the "Captain" is 11½ feet out of the water. Am I right?

Captain COLES: Yes.

Captain SCOTT: Very well, the gun in the "Monarch" is to be 17 feet out of the water—that vessel which is so much objected to. Now, in Admiral Yelverton's report, at page 7, he states, "The turret-system of arming a ship "would have a great triumph on this occasion, for there is no doubt that a "sea-going turret-ship, say 12 or 14 feet out of the water, would have fought "her guns without the slightest difficulty, and have fired easily six shot to every one "from our broadside-ships. I do not here allude to the 'Wyvern,' for the sea would "have washed into the ports of her turrets and swamped everything inside." The Admiral here expressly points out that it is a vessel with high freeboard—a vessel whose gun would be 17 feet out of the water, which is precisely what the "Monarch's" is, that would have had an advantage over his squadron.

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The CHAIRMAN: I do not think it is so stated there. It says "the gun."

Captain SCOTT: It does not say "the gun." It says, "a sea-going turret-ship, say 12 or 14 feet out of the water."

The CHAIRMAN: Read the whole of it.

Captain SCOTT: "There is no doubt that a sea-going turret-ship, say 12 or "14 feet out of the water, would have fought her guns without the slightest "difficulty, and have fired easily six shot to every one from our broadside-"ships. I do not here allude to the 'Wyvern,' for the sea would have washed into "the ports of her turrets and swamped everything inside." But the sea in the same manner will roll over the "Captain's" deck with a low freeboard, and, to use the words of the Admiral, "swamp everything inside her turrets." The very incline of her deck will tend—will materially assist this action. Look at a breakwater, and see how the sea rolls over it; but on dropping the port, as you can in broadside-ships, and loading through the scuttle, the whole weight of the sea may come flying against the port, but it cannot sweep over the deck and swamp everything inside. I turn again to the Admiral's report—to pages 2 and 5, to see the value of the vessel with the low freeboard. "On both these occasions I was able to "judge of the performance of the squadron, blowing hard with a heavy sea, and "have no hesitation in saying, that under all the circumstances of bad weather in "the Atlantic, I see no reason to apprehend that the ships of this squadron would "make worse weather of it than any of our line-of-battle ships. I must, however, "make two exceptions to this, namely, the 'Hector' and 'Wivern,' neither of "which are, in my opinion, in their present condition safe in bad weather; the "'Hector,' from the difficulty (if not impossibility) of getting rid of the water she "would be certain to ship, if caught in a cross sea caused by a sudden shift of wind; "and the 'Wivern,' from being so low in the water, that with the everyday Atlantic "swell only, she is compelled to be battened down, if not head on to it, and even "then the sea breaks over her deck in a way that renders it a service of danger for "the men to pass along it. On reaching the cruizing-ground she was soon short of "coal, and I was obliged to send her to Bantry to fill up; but the experience I had "of her performance up to that time convinced me of her unfitness to keep the sea, "and I ordered her to remain at Bantry until the end of the cruise, when she joined "me having to put back on one occasion in the face of a strong south-easter. I was "subsequently informed by Captain Burgoyne, that on the occasion of steaming down "Channel, this vessel had two of her fires partly extinguished through shipping a "heavy sea, which circumstance has already been reported to their Lordships. The "'Wyvern' does little under sail, and is totally unfit for the duties of a sea-going "vessel, but she is well adapted for coast defence." Now, I was one of those present who saw the "Wyvern's" pitching and rolling, and certainly she did it to a very considerable extent. She had netting triced up on each side, and on one occasion a heavy sea rolled on board of her, and when it left, the men were caught in one of the nettings, like fish, safely bagged and brought back. Again the helmsmen could not pass along the deck without a wetting in ordinary weather. As to the "Wyvern," the Admiral further says, "This vessel could never have been intended as a cruizing or sea-"going ship, for, although she is buoyant and rises to the sea, yet from her being so "very low in the water, it rushes up her sides over all, and when broadside to the sea, "it is impossible to move about on her decks without the risk of being washed over-"board. At sea she is almost always battened down, to the exclusion of air in the "engine-room and stoke-hole. Under sail she does very little, and her stowage of "coal is limited." I will make one remark with respect to her stowage of coal—when Captain Burgoyne filled up, being ordered to rejoin the squadron the last time, he did not consider it safe to take in the whole quantity of coal, and therefore took considerably short of the quantity. The report continues: "If the 'Wyvern' had to cross the "Atlantic, I would suggest that she be fitted with a fore and aft bridge, like the "'Miantonomoh,' and, like that vessel, be escorted by a powerful steamer." Now, if the "Wyvern" was not built to cross the Atlantic, and operate along a stormy coast, for what on earth was she built? Next with regard to sail power, so necessary in cruizing. As you see Captain Coles' imaginary vessels, because I must call them so, are to have little or none. I suppose I make no mistake, however, in saying that

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those are sails (pointing to diagrams). They cannot be the sails of a boat hoisted in the centre of the ship. I see they are the ship's sails, but on the hurricane-deck shown, would there be room to work a vessel's sails properly? I ask any one to look at the amount of room on that hurricane-deck to work a vessel under sail.

Captain COLES: 24 feet broad.

Captain SCOTT: As respects the value of sail power, I may mention that the "Research" was ordered to rejoin the squadron. Of course the "Research" had very small steam-power, and so the squadron steamed away and left me behind. I could not help myself. But being ordered to rejoin, and steaming out of Cork, just as I got abreast of Daunt's rock the vessel broke down. In the evening, the Admiral had said to me, the weather was so bad, and there was such a nasty sea on, he thought I had better not go, but if, in the morning, I was still anxious to leave, I might go, so I went. There was a very nasty sea, a tumbling sea, close to Daunt's Rock. We were making a close shave of it, for we could not afford to burn much coal. I thought it possible that the "Research's" passage would be timed, and immediately made sail. We wore at once sharp round close to the rock and stood over across to the other side and worked out under sail against the breeze and against the tide. There we were beating to windward some hours, until the Engineers repaired the valve, which had broken, and then we went on again, steaming and sailing. Now there is a case, in which, if the vessel had not had sailing power, I do not know what she could have done. We could not have anchored off Daunt's Rock. We must have gone ashore there. Next as to the accommodation of the turrets, I will turn to page 169, in the House of Commons Return on Turret-ships, and read to you what is said, because there is nothing like what is official as to matters of fact: "The space occupied by the turrets and the absence of "gun decks, renders it difficult, if not impossible, to provide properly for the "accommodation of officers and ship's company; while the necessary clearness of "the upper deck prevents her from carrying the requisite proportion of boats, "spare spars, and other gear, which must ever form a necessary part of the "equipment of a man-of-war."

Captain COLES: What report is this?

Captain SCOTT: That is what Admiral Key gives as a summary, and places in the hands of Government as an official document summing up all those points.

Sir FREDERICK NICHOLSON: It is the Report of the Earl of Lauderdale's Committee.

Captain SCOTT: Yes, the Earl of Lauderdale's Committee, I have read from the paper, because I wish to go point by point through it. The turrets are deficient in offensive power, because they are too low to fire down upon torpedoes which will be largely employed, I doubt not, in future warfare. You see the deck of the turret ship is also in the way. The amount of depression the turret guns are calculated to give is only 5 degrees, and from this small amount of depression, and being so low in the water, they lose the valuable point of being able to fire *down* not only through a torpedo, but through any other vessel alongside of them. The decks of vessels, up to the present time, are not armoured, therefore, I think, the height of the gun is a very great advantage in enabling you to fire down on a vessel that may be alongside. Secondly, the turrets fire very slowly, because space is limited. If you look at that diagram, you will see at once what a small amount of space there is for loading. These (pointing) are two 600-pounders, I believe the turret is the size of that which is to be in the "Captain;" and the general arrangements are the same.

Captain COLES: What is the diameter of that turret—the interior diameter?

A MEMBER: It is probably 25 feet.

Captain SCOTT: It is in proportion to the size of the gun. I will tell you what it is taken from. I succeeded some time ago in getting a sketch of the turret devised by you at the end of 1865 for two 600-pounders, it was sent up to the Admiralty. This is the exact copy of it.

Captain COLES: That is not the "Captain's."

Captain SCOTT: It is very similar to it?

Captain COLES: No.

Captain SCOTT: If you say it is a foot larger or smaller, I will take it at that.

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Captain COLES: It makes a difference in the diagram.

Captain SCOTT: But for all practical purposes, as to space, it is the same?

Captain COLES: That will make all the practical difference in the illustration.

Captain SCOTT: I shall be happy to allow you the benefit of a foot or two either way, if you will point out where it is wrong; but, as you can see, the space is exceedingly limited, owing to the roundness of the turret. This platform is very nearly 4 feet high. The man has to get on it in order to load, so that passing up the shot and powder, especially when the ship is rolling, with the sea coming in, would be a service of no slight difficulty. The man cannot stand upon the deck, as in the broadside, and he has not room to load; therefore, you will find invariably, the firing of the turret gun exceedingly slow. Actual turret warfare confirms this; and the firing of the "Royal Sovereign" has shown exactly the same result. Now, as to Captain Coles' Report on the quickness of firing, in the Trusty's Turret, there is a very simple solution to that. The gun was only a 40-pounder, and in the turret, was mounted on an inclined plane, so that when fired it ran out again, and as it was a breech-loader, it could be loaded at once; whereas the gun mounted on the broadside had to be run out by the crew. That made the difference, and in that lies the difference in the times of firing. Whether Captain Powell made the mistake I cannot tell, but that is the real reason of the difference in the quickness of firing in the Trusty. We will turn to page 168. Here are all the experiments with the "Royal Sovereign's" firing. It is only necessary to give them generally.

Captain COLES: Will you state the year it took place?

Captain SCOTT: The 3rd of October, 1865, is the date of this report.

Captain COLES: This is 1867.

Captain SCOTT: I will give you also the firing of broadside guns in 1865, and then put the two side by side, year by year. With the one-gun turret, (we wont go to the two,) there was an interval of one minute and twenty-three seconds between the firing the rounds, and this was the quickest number of rounds that were fired. What Admiral Key says is this:—"In the 'Royal Sovereign' a gun's crew of 30 "men who had been carefully trained in a turret for nearly a year, and who had "fired about 100 rounds with shot, beside much practise without firing, completed "ten rounds as follows, the quickest ten consecutive rounds being selected, *vide* "Report B." And these are the quickest ten consecutive rounds that were fired. They occupied 13 minutes and 51 seconds. The gun carriage that was put on the "Minotaur" was completed in 1865; but the experiments did not take place until January, 1866, as there were no competitors ready. Sir William Armstrong was to have come forward as a competitor, but did not. One of the Arsenal carriages did however turn up. That gun carriage had only four men at it, who had been at the "Research's" iron gun-carriage before, the others were taken from volunteers. The whole crew of the ship volunteered to go. The gun's crew was 14 men, not 30, as in the turret. The firs time they fell in, the gun was fired ten rounds in eight minutes and fifty-four seconds.

Sir FREDERICK NICHOLSON: At a target?

Captain SCOTT: No; under just the same circumstances as the others. We are taking the quickest ten rounds. The crew pointed every time and turned the gun.

Captain COLES: In this case, with those two guns a small target was fired at 1,000 yards distance, and good practice made. That is very different to firing at nothing. That is child's play. Any one can fire a gun off.

Captain SCOTT: But as to the very quickest interval between the rounds—there has been no shorter interval on board the "Royal Sovereign" than one minute in all the firing there. In the "Minotaur" following up this first quick firing, the later rounds were only with half-minute intervals. Ten rounds were fired in four minutes and forty-eight seconds. Another ten rounds in five minutes and one second. Now you will see what it really comes to, as to quickness of firing. In the "Bellerophon" the other day with elongated shot which are exceedingly difficult to load, not the round shot, which were tried in the turret, but with elongated shot weighing 260 lb., instead of the 150 lb., round ball, five rounds were fired in three minutes and forty-one seconds. With respect to the rolling, I need not touch upon that, because the "Wyvern" rolled quite as much or more than the "Research," and

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in the recorded rolling you will find that the "Wyvern" rolled as much as any vessel in the squadron. As to the favour shown; I have understood that £18,000 was spent on the "Scorpion." The outlay on the "Research," has been £11,000, including putting a deck on her, and making her in fact a very different vessel, and a very comfortable one. This is altogether from first to last, on her fittings and on her alterations, and everything that was done. She has been very considerably more than three years constantly employed backwards and forwards. The "Royal Sovereign" has been continually in hand, and I believe she has been in hand for the last six months.

But let us now examine the relative power of the Broadside and Turret vessel, and suppose the case of two enemies engaging the "Bellerophon," and two engaging the "Captain"—in one case we have a broadside in the "Bellerophon," of 1,500 lbs., and in the case of the "Captain," of about 1,200 lbs against each enemy. If you take the quickness of firing to be inversely as the size of the guns, that of the 600-pounders would be very slow, and I should say the weight of metal discharged against two enemies by the "Bellerophon" from her being able to discharge on both sides together would be treble, certainly more than double, that of the "Captain." The "Monarch" I saw a few days ago, and I am happy to state I did not see that she was being turned into a box. As the semi-turret has been spoken of, I may state that the guns are put out here, the after gun fires right a-beam and right aft, and the forward gun right a-beam, and also right forward, so that these two guns can fire right a-beam, and command a-head and a-stern. These two guns are a very great height out of the water. They are over 20 feet. I do not think that that is a semi-turret: it is a fixed thing. Of course we give Captain Coles all credit for the adoption of the turn-table which is a very great advantage, the distinctive feature being a turn-table which carries the gun upon it, enclosed in an armour casing. I may here say a word or two about one's own particular vanity, but first I wish to show that the turret has been well considered and well developed, I think Captain Coles has had great advantage in that respect. He has been working at it continuously, and his suggestions as to mounting the guns, and on almost all points, have been carried out, which has not been the case with the broadside vessels.

Captain COLES: May I ask how you know that?

Captain SCOTT: As far as I see, and as far as what you have done, I believe it is pretty nearly the fact. For fast cruisers I have been inclined to give up armour altogether, and to get great height of free-board out of the water, trusting to the power of the guns to keep down in a great measure the attack of any rival vessel. I consider that we could not go far wrong in building fast unarmoured vessels; and therefore as one development of the broadside, I have taken a small turn-table, and having 12-ton guns upon each side, have used it so as to gain the power of firing a-head or a-stern; (all those three guns will fire within 13 degrees of the line of the keel forward or aft). My idea is to fire with great rapidity, which you can do on the broadside, and within 13 degrees of the line of the keel. You may discharge your three guns, you may shear your vessel only through 26 degrees, and then you may discharge your other guns; and you get a great height out of the water. This sea here is shown exceedingly small, (pointing) but the Atlantic wave is about 12 feet in height, and would continually interpose between the turret gun and the broadside vessel.

Captain COLES: The turret gun is 12 feet in height, the same height as the broadside. My principle is the same height in ships of the same class.

Captain SCOTT: I am alluding to the "Captain." The gun is low: it certainly is not high. If the gun is high it does not represent the "Captain." That seems to be a high freeboard and a high gun, and it does not carry out the principle of the low freeboard.

Captain COLES: Oh yes, it does.

Captain SCOTT: Certainly it does not illustrate the "Captain." I have made a few remarks on this subject. It is one that needs very great consideration, and I believe that these discussions have a very good effect, for we are shown our weak points, which we cannot see before. We are all too fond of our own plans; and in laying them before you of course we get them fully discussed; and in fact, the wheat

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is sifted from the chaff, which I hope will be the case at the present time, and that all of us, working together as we are doing, may assist—because that must be the ultimate object of us all—in placing our country in such a position that she shall remain the unrivalled mistress of the seas.

Vice-Admiral R. S. ROBINSON, Controller of the Navy: Mr. Chairman: It is with extreme diffidence that I venture to address the audience that I now see before me, for several reasons. I know that the subject on which I am about to speak is one with which most people here are not only thoroughly acquainted but on which they would deliver their opinions in far better language, and in a far clearer style than I can possibly attempt to do. In the next place I have not had the advantage of hearing the commencement of this lecture, or hearing what the gallant officer Captain Coles has, I have no doubt, so well and so ably put before the meeting, and I am therefore rather in the dark as to the points on which I wish to direct my observations. But this to me is perfectly clear: we are discussing a question of the very greatest moment, a question on which all personalities should entirely disappear. However amusing it may be, and however advantageous for the moment it may be, in discussing such questions as these, to make use of a personal argument, or to give a home-thrust to an opponent, the cause of truth—that cause which we know is at the bottom of every man's desire in this assembly—the cause of truth suffers in the end from the temporary triumph anybody may obtain by a good hit and a smart thrust. Now I wish as much as I possibly can, in discussing the question which I wish to discuss, to avoid personalities. If in advocating the views I have to advocate, I am unfortunately led to mention anybody's name, I trust that I shall mention it in such a way as to give no cause of offence to that person, and should I by any accident make use of an expression in the fearless and free discussion which I court for my own opinions, and which I think that others will be equally willing to accord to me the liberty of using—I say, if by any accident, any word or phrase of mine shall hurt any such person's feelings, I apologise beforehand, and request him to attribute it only to my unskilful use of the weapons I wish to use, and not to any desire to be disagreeable to him. I should also apologise, before going much further into this subject, for one point which you will very soon find out. My occupations and my avocations day by day are so laborious, that I stand before you not a strong man, not a person capable of making much exertion, and in general, at this time of the day, so completely overwhelmed by the labours that I have to undergo, as to be little fit to address an audience. Now, Sir, the subject which we have to discuss, which I wish to do with as much philosophy and knowledge as I am able to bring upon it, is "the turret system *versus* the broadside system," and I wish to discuss that subject rationally and logically. To do so, we must have a clear understanding of what is meant by a turret-ship, and what is meant by a broadside-ship. Now I stand before you—and perhaps some of you who have found out that I am the Controller of the Navy may be surprised when I say that I stand before you the oldest, the most consistent, and the most persistent advocate of the turret system—yes, of the turret system, for that which it is capable of doing; not of a system which is incapable of performing the work we want it to perform, but the advocate of that system which can perform it, and which can perform it better than any other. Quite in the early days when Captain Coles commenced his most meritorious labours—labours for which I give him all possible credit,—I met my friend Captain Coles—if at this day I may call him my friend—I met with my friend Captain Coles in a state of extreme difficulty, having got his system, the excellence of which was evident to me, before a certain department of State which I will not name, and having got himself into extreme trouble and difficulty with that department. He was kind enough to take me into his model shop, and to show me the inventions, which with so much skill and talent he had prepared for that department, and he also showed me some correspondence, which proved that they were very great difficulties in his way. I am happy to say I was the means of removing those difficulties. I am also happy to say some time after that, I became Controller of the Navy, and was able to forward the views then entertained by Captain Coles, of the turret system. I only state this much to show why I say that I was one of the oldest advocates of the turret system. I may say, without speaking too much of myself, that I assisted Captain Coles extreme-

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to get the first turret that ever was tried, brought not only to the notice of the Admiralty, but tried in a ship under fire. I assisted Captain Coles moreover to get the first turret-ship that ever was designed or laid down, namely the "Prince Albert." Now I do not want to say more upon my persistency or consistency in advocating the turret system, for what it is fit, and not for what it is not fit. I have persistently and consistently, and do at this moment contend that the turret system, as applied for purposes of either coast defence, inland navigation, or siege artillery, to attack an enemy's port or roadstead in inland waters and in fine weather, is the system of all others in which you can combine the greatest amount of offence and defence. I have never deviated from that opinion, publicly or privately. I advocated it eight years ago. I advocate it now; but because I advocate for a particular purpose a particular weapon, I am not, I think, bound, either logically or philosophically, to say that this weapon, which I believe and know to be the best weapon for that particular purpose, is an equally efficient weapon for all other purposes. I know well, for instance, what you can do with an axe. I know, I have seen work well done by barbarians, if I may so call the Chinese—with an axe, but no one would tell me an axe is able to do all that a saw is able to do. And so while I say, and say with a certain knowledge and clear conviction of the fact, that a turret ship for coast defence and for the purposes I have named, is the very best weapon you can use, I use my judgment, and I have within myself as clear a conviction, founded upon argument, reflection, and logic, that this may not be the best vessel for sea-going and cruising purposes; and to explain more fully what reason I have for this assertion, I would like this Meeting to consider for a moment with me what is the very best form you can give a turret-ship for the purpose of hostilities in inland waters, whether for offence or defence. In inland waters you are restrained by none of the difficulties which the ocean puts into contact with you. You have simply to know how much weight you intend to carry upon the vessel, and to proportion your carrying power to the weight that you intend to put. The lower, therefore, any such vessel can be constructed, the better; the less the draught of water such vessel can be constructed with, the better; all that you require in such a case is a vessel so strong in every part that no shot shall be able to penetrate it, except under circumstances which we must give up, because we cannot absolutely overcome the power of artillery; but under ordinary circumstances you can construct, for the purposes of coast defence, or, as I have said, for siege artillery, without the smallest difficulty in the world, a vessel low in the water, coated with armour-plating, and carrying the heaviest possible guns, and this you may do comparatively in small dimensions. Now when the idea dawned across the gallant officer, it was a great idea; the idea dawned across him to put a gun upon a turn-table, and to surround that turn-table with armour-plating; he came positively upon a very great invention—a very great and successful idea came across his brain. He has laboured in various directions with assiduity ever since, but the first thought, and the first realization of that thought, must have been to him a very considerable and great satisfaction. It is that thought, that idea, embodied in a low level armour-plated vessel like what is now known as the "Monitor" vessel, which is the most perfect conception to my mind of what you ought to have for attack and defence of ports and arsenals, and if the gallant officer had stopped there, I should have said he had done quite enough for his fame—quite enough for the benefit of his country and for the benefit of the world. He has, however, (and he is perfectly right—he views the thing in a different light to what I do—his reflections upon the subject have brought him to a different conclusion from the one I have come to)—he has conceived that there was no more difficulty in adapting this system of turret-ships—that is to say, carrying a revolving gun on a turn-table, surrounded by an armour-plated shield—there is no more difficulty in carrying that in a vessel to contend with the waves of the Atlantic or the stormy ocean, it would have to cross, in conjunction with very great speed, than in making the "Monitor," or the coast defence vessel to which I have just referred. Now it would not be difficult to show that that cannot be; it would not be difficult to show that however excellent the system which requires lowness, for instance, of freeboard, (it is a vital point in a "Monitor" that you should not

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expose any of her;) it is not difficult, I think, to show that although that requisition may not be incompatible with a perfect coast-defence vessel, or with a perfect piece of siege artillery, yet that the requirements of a sea-going ship, are entirely different, for the moment you get into waves and into sea-way, the lowness of freeboard signifies at once, that your gun cannot be high out of the water; if your gun is not high out of the water, there come between you and your object various waves more or less high, and your artillery is paralysed. For instance, if your gun is only five feet out of the water—take that as an illustration—these figures will illustrate it better than anything else—say that your gun is only five feet out of the water, and the enemy is 500 or 600 yards from you, how many waves, twelve or thirteen feet high, will there be between you and your enemy? However little the rolling of the ship may be—(we will give the gallant officer the advantage of supposing that his low freeboard will exceedingly mitigate the roll of the ship, which I do not deny for a moment, provided it be really low)—yet he can only fire at his enemy when he is at the top of the wave, and he cannot fire at that enemy's water-line when waves thirteen feet high are between him and the enemy; therefore one great advantage of his artillery is lost to him when he takes a low freeboard as the condition of a sea-going ship. And let me put the alternative. He says, Well, I will not take a low freeboard for my sea-going ship; I will take a high one for the sea-going ship; he at once departs from the principle that he has advocated so long and so persistently, that the great advantage of a turret-ship consists in its lowness and in its smallness; for it must be evident to everybody who has ever considered these subjects for a moment, that when you begin to talk about the lowness of a ship, a very low ship alone enables you to have a small ship; but the moment you determine that your artillery shall be mounted at a considerable height above the water, all the conditions of equilibrium, sea-going, and sea-worthiness demand that you should have at once a high and, therefore, a large ship. There comes in, therefore, at once an objection to which I have never heard a satisfactory reply, to endeavouring to make small turret-ships sea-going, especially when combined with speed; the speed that you can obtain, and the weight that you carry in all ships must necessarily be antagonistic one to the other—that is to say, that you may turn with the greatest ease the weight that you carry on a ship into speed; or *vice versâ*, you may turn that speed into weight by reducing the speed. Those two things are convertible. If, therefore, we are going to have a swift ship on small dimensions, we must sacrifice something; we must either sacrifice some portion of the armour-plating or some portion of the armament, in order to obtain a power to drive the ship at the rate at which she is to go. The two things, the speed and the weight to be carried, are, *cæteris paribus*, perfectly interchangeable. If, therefore, you are going to ask us to construct small turret-ships with low freeboards, you deprive us of the artillery, or rather of the power of placing that artillery in such a manner as to be really efficacious to use, and you deprive us of the power of obtaining great speed. Those difficulties are, to my mind, almost insurmountable, as to the possibility of perfecting a sea-going turret-ship with low freeboard and of small dimensions; but this does not affect the question the least in the world of a turret-ship properly designed of large dimensions and with a high freeboard. The question, then, between the turret-ship and the broadside-ship stands upon an entirely different ground. Now, I must say, as I said when I commenced, I do hope in what I say I shall not give offence, but it is my firm conviction that the great opponent of the turret-system, as applied to sea-going ships, sits in that chair. That may seem extremely odd to many—the greatest opponent to the turret-system as applied to a sea-going and a cruizing ship, is Captain Coles; and for this reason, that, in my judgment, he has advocated impossibilities. He has refused to accept, as a principle of a good sea-going turret-ship that her guns should be high out of the water. He has contended that the true principle of a sea-going turret-ship is to have her guns low in the water. Now, I stand here to advocate that the true principle of a sea-going turret-ship is, that her guns should be high out of the water, and not that they should be low. I have already said that the true principle of a coast defence, the true principle of a piece of siege artillery, the true principle of a ship built to contend, as the Americans fought their actions, in inland

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waters, is a low freeboard; but that the true principle of a turret-ship to contend with the waves of the sea, to be a cruizing ship on the ocean, to give accommodation to her men, and to go into action with a certainty of overcoming all her opponents, is in truth a gun high out of the water, and not lowness of freeboard. It is this particular point that is most interesting to me, and that has induced me to come here, and however imperfectly (as I know it must be, however much I may have wearied everybody here) I have endeavoured to point out what I really think is the true philosophy of the turret-system, there is no question of this—that we can do this much—we can mount very heavy guns in our turrets, we can carry those guns at a considerable height out of the water, we can, under certain circumstances, that will occur to everybody, enter into action with another ship with every prospect of success provided we are not restricted by small dimensions; but I do not think that even that much proves, so entirely as I dare say some of the advocates of the turret-system think it proves, that you should build nothing but turret-ships, or that turret-ships alone are sufficient to maintain a Navy like that of England in all the conflicts and all the diversities of service that that Navy would have to go through. I do not think it can, but I am perfectly willing to admit, and I desire to impress upon everybody who hears me, that we are persuaded, and have been persuaded for a long time, that the proper application of the turret-system to a sea-going cruising ship was the exact opposite of what its worthy inventor, its parent I may say, thinks it ought to be. I am sure anybody will understand how difficult, therefore, it has been ever to come to any understanding on the subject. I have the strongest possible belief, founded, I think, on positions that cannot be shaken—that the high gun is essential to a turret-ship; a low gun cannot be used effectively in a sea-way—a low gun could only be fired, as I said before, when the ship is on the top of the sea, and even then, between her and the enemy there may be waves so high—because the height of waves differs in half-a-mile it may be, several waves of one height and several of another—the wave will be between her and the object, and she will not be able to see the object or to strike it; whereas, if the gun were fifteen or twenty feet out of the water, you would look over all those waves and see your object from first to last. When upon the deck of a vessel in a gale of wind, that deck being from fifteen to sixteen feet high, we have all repeatedly seen a vessel within 300 yards of us disappear, and have seen nothing but his main topsail, but go to the masthead, and there you will never lose sight of him. Although that is an exaggeration of the position I wish to maintain, of the great advantage of the height of the gun, it is an illustration of how necessary it is, in a sea-way, to have a high freeboard and a high sight, all of which complicate the difficulties of constructing a ship in a very remarkable manner. I only wish to refer to one other subject, and it is one which applies not only to what I have now been saying, but it applies to all turret-ships as a general rule. It is a subject of considerable difficulty, and I should not have mentioned it if I had not seen it constantly and persistently overlooked. I am not bringing it forward as an absolute argument against the system, but only as one of the difficulties of the system—as one of the things we have to consider most carefully before we rush headlong into turret-ships. The turret invented by Captain Coles is, as you know, armour-plated above the deck. When it passes through the deck it ceases to be armour-plated, and the whole structure of the turret and the mechanism of the part on which it revolves, is entirely unprotected by armour-plating on itself, though it is defended from anything that may hurt it by the ship's side—that is, by the armour-plating on the ship's side, but it has no other defence. Now, unfortunately—I was going to say, those confounded artillerists, but those terrible artillerists, as soon as ever we contrive to get an armour-plate and some backing of some given strength or another, that resists, for the moment, all their efforts, do invent some horrible gun, and go clean through all our defences. It is very annoying, no doubt, and very provoking, but, however, they will not stop for anything that we can say; we know they do go through 8 inches of armour-plating and a considerable number of other defences. We know that if a shot or a shell passes through a ship's side in direct fire at 200 or 300 yards, that shot or shell striking upon the base, the unarmoured part, of the turret, where all the machinery is, would infallibly bring the whole of that turret to grief. Very little indeed would jamb the turret, and would prevent its

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rollers from turning round, and very little indeed, in my opinion, would break through the unarmoured structure of the turret. That is not a fatal, not a vital objection, but it is an objection which people ought to weigh well before they put the whole of their guns into turrets. Recollect, according to the most general scheme that we are acquainted with, two turrets are the most that you find in a ship; therefore it is possible—I do not say it is very likely—but it is possible—that a couple of shot from an enemy's broadside might disable both turrets. Now, what is true of a turret-ship, is undoubtedly true of a broadside-ship; there is no question in the world, that shot and shell will find their way between the guns or above the guns, or into the centre armour-plated battery of any ship, whether turret or broadside. What happens? A certain amount of loss of life in one case, a gun disabled perhaps, but your broadside with six or eight guns on one side, stands the blow, and goes on. You have lost a gun, you have had a gun dismounted, you have a gun's crew killed—you cannot fight without these unpleasant accidents occurring—but you are not utterly disabled; you have still other guns and other men to come forward and carry on the fight, and we know very well most of our actions have been won when we have been half-beaten; but it is another consideration when your two turrets are your whole offence and defence, when you have no other;—one of these shot, or two of these shot passing through—and we know that they will pass through—may utterly disable or jamb the base of your turret and prevent its being used any more. As I said before, I do not the least intend to use that as an argument against the turret system; I only say that it is not all on one side; that there is a great deal to be said on every side of the subject—that it would not be prudent, that it would not be right, to embark the whole of the British Navy, or any considerable portion of it in turret-ships without further experience than we have now had; and I may say this—that so far from there being any disposition on the part of anybody in office or out of office, to my knowledge, to discourage the development of the turret system, very much the contrary is the case. Of course, like a member of the Cabinet, I have no business to retail Cabinet secrets; what passes, therefore, over the way at Whitehall, and the discussions that take place on this subject, of course you will not expect me to say anything at all about, but I think there are evidences which all here must be well acquainted with, that the subject has not only been most carefully considered, but has extremely warm advocates in that council chamber to which I have referred. Certain speeches which have been made in Parliament and elsewhere, certainly prove, I think, at least that there is no unwillingness to consider the turret-ship in all its points and in all its bearings. There is only one thing more I think I may refer to, which I believe was extremely well done by my friend Captain Scott. It is this. I did not hear, as I said, the lecture the other day, but I know that there is a strong desire and a strong feeling to represent the imperfections of broadside ships, as much as they possibly can be represented; and those who think a broadside ship is wrong in principle and wrong in practice, and the turret-ship is right, do well in every possible instance to advocate their opinions fairly, and represent all the evils which belong to the broadside-ships; but what I was going to say is this, there are every day in the broadside-ship improvements made which add enormously to its offensive and defensive character, and which take away many of the objections which are constantly urged against it. I am sure almost everybody in this room is familiar with the talents, with the labour, with the energy, with the unwearied zeal displayed by the Chief Constructor of the Navy in those productions which he has turned out. I think everybody will be aware that he improved the designs of the ships, improved the construction of the ships, and has been in a measure successful to an extent that perhaps it is hardly my province to say. He has shown, in every instance, the greatest possible desire to improve our constructions, his success has been prodigious, and at this moment I speak, having seen the opinions of many persons who have come to this country purposely to investigate our iron-clad ships, who came here with a desire to find fault with our Navy, who came here thoroughly impressed with the beautiful descriptions that the press sometimes gives of our performances, and believing that we were a pack of old women, and that we had no Navy, and were ready to be eaten up whenever they thought proper to open their mouths and swallow us. I have

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the means of knowing, from letters that I have seen, that one and all have left this country with the impression that she is unrivalled in her constructions at sea—unrivalled. I am also able to say this one word—that the Assistant Secretary of a foreign Navy was over here for some considerable time, and was asked at a diplomatic dinner the other day, what chance our neighbours would have with us? It is as well not to give you that reply. But he was further asked, "What chance should *we* have with the British Navy?" He answered in these words, "You "have got the finest line of defence on the waters in the world. Nothing "can attack you, and your defence is perfect; but if you attempt to go to "sea, if you attempt to cross the ocean, you would not be six months, before you "would be swept away completely. You have not got a single iron-clad sea-going "ship in your whole Navy;" and he said more—"I went to Chatham the other "day, and the most splendid specimen of naval construction, I ever set my eyes on, "both in design and construction, was the 'Hercules.'" I need not tell you Mr. Reed was the designer and the constructor of the 'Hercules.' I think all this is satisfactory. I am endeavouring, by what I have now said about broadside ships to point out that there is in broadside ships some virtue—that they are not altogether, as we have sometimes heard it said, absolutely out of date. The last construction in broadsides that we have put before the Admiralty, contains one or two features Captain Scott referred to, and which I think are of so much importance, as doing away with the objections generally made to broadside ships, that, at the risk of wearying you a little longer, I will state them. Of course everybody is aware that the great objection made to broadside ships is the want of power to train the gun upon all points of the compass. The great merit of the original idea that came across Captain Coles' brain, was that his turret could be pointed to every part of the compass. But he has been led astray by a will-o'-the-wisp, giving up his first love for something more specious and telling; he has given up that idea, and given up that all round fire, which was so precious to me and to all other consistent advocates of the turret system, and he has now gone in to limiting his fire. I regret it extremely. There is in the "Captain" a want of all that round fire which distinguished his early plans; but I say that the broadside gentlemen—those who are responsible for the construction of broadside ships—have now adopted a plan by which such a ship will command every point of the compass. In addition to those guns in the central battery—which has so often been denominated a box by way of depreciating it—not only have you guns in the box, but upon the upper deck, at a height, as Captain Scott has said, of something like 20 feet out of water, giving you, therefore, a tremendous command over anybody alongside of you, we have put two guns that will fire in a line with the keel and at a right angle to it. I see a gallant officer here—I am very glad to see him here to night—who has persistently advocated that principle in various ways, and who, I have no doubt, will be pleased at the development we have given it; for if we have not absolutely adopted all his recommendations, we have profited very much indeed by the lessons he has given us. We have got that fire, that fore and aft fire, which is to him so extremely precious, and which he has been for a very long time, not only a theoretical advocate for giving, but has in the ships whose construction he has directed, adopted with the utmost ability. It is satisfactory to be able publicly to say that that officer, Captain Symonds, has at all times, in many ways, contributed to us a vast amount of useful information—that he has put his models and his plans very often, indeed, at our disposal, and given us the benefit, and a very great benefit it is—of his talents, and of the attention he has paid to that subject. There is but one thing more, on the subject of broadsides. I am extremely sorry to have detained you so long, but I should not do justice to what I have to say, if I did not revert to this one point. The heavy gun in a broadside can only be worked by mechanical means. When, in 1863, the fact became evident that heavy guns would really succeed—(as everybody here knows, there was considerable doubt for some time—gun after gun burst—and those who were responsible for the adoption of ships to carry those guns were naturally staggered for a considerable time, and began to have a little doubt whether the big gun—the rifled gun—would stand the severe shocks it was exposed to, and would ever be a gun served out to the Navy for use:)—but in 1863, my friend Mr. Reed, with that prescient foresight

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about naval matters, which we have always known him to possess, and which is invaluable to a person in the official capacity that he holds, became thoroughly convinced that 12-ton guns would not only exist, but be mounted and worked in the broadside ships. At that time, I remember perfectly well, there came a number of naval officers to the council, that I have spoken to you about, and there was a great discussion, and the opinion given by all the naval officers was, that only a 5-ton gun could be worked upon a broadside ship. Now, it required some courage, and some knowledge of mechanism, and some confidence in his own resources, and in his own good sense, to induce Mr. Reed to say, I will build a ship, and she shall carry 12-ton guns to work on the broadside. And now came the question, how we were to work those guns. It was clear the plan of working a gun by handspikes would not do; for a long time it was persistently attempted to work these 12-ton guns on the broadside with tackles and handspikes, but there came upon the scene somebody who changed all that. I am happy to introduce Captain Scott as the person to whom we owe the change that has now taken place, in the opinion of all naval officers—a change, from the idea of its being absolutely impossible to work 12-ton guns on the broadside, to the conviction that it is the easiest thing in the world.—It is simply by the application of mechanism, and the mechanical foresight of Captain Scott, with an assiduity and a labour equal to the assiduity and labour which Captain Coles has bestowed upon his turret-ship, that he has worked out a system by which the heaviest guns are worked at sea, not only with as much facility, but with greater facility than the old 68-pounder on its gun-carriage. I am happy to say, that this is now a recognised fact. It required many trials and much perseverance on Captain Scott's part—it required a man whose temper was such, that he would take no denial; that he would work on in spite of all discouragement, and he has done so. The other day, I am happy to say, I read a report from a Rear-Admiral and five Naval Officers (a committee for mounting and working naval guns), who declared the difficulty was over, and that heavy guns could be worked on the broadside with perfect facility. The burden of what I have to say is this—pointing out the difficulty of getting a sea-going ship as a turret-ship with a low freeboard, pointing out the inevitable and insuperable objections to such a ship, and showing, as I think I have shown, the great facilities that now exist for mounting heavy guns on the broadside principle,—I think I have put the question on a fairer and more rational basis than it has yet stood upon. I think I have shown—or, at least, I hope I have shown, to this meeting, that it is perfectly possible to have the very best defence, and the very best siege artillery you can have in low turret-ships; that it is possible to have a sea-going turret-ship, provided you will give up the low freeboard, but that there is no reason whatever for supposing that the lately designed broadside ship mounting heavy guns upon its broadside by mechanical means shall not go into action with a turret-ship with equal chances, and that it is skill, nerve, resolution, whatever you please, that would decide that action.

Captain TYLER: I think we must all thank Admiral Robinson for the very able way in which he has spoken upon this occasion. Captain Coles gave us, with great ability, his side of the question, and we have now heard from the highest authority the other side of the question, in a manner with which, I think, we must all be charmed—in consequence of the impartiality and kindness with which Admiral Robinson has spoken of everybody concerned. Sitting opposite to this model, I have been watching it as Admiral Robinson spoke, and I have been struck with it as a most excellent illustration of what he has been telling us. Comparing *this* broadside vessel with this turret-ship, as a sea-going vessel, it struck me at once that, in order to arrive from the one vessel to the other vessel [pointing], you have to take a slice out of the former vessel on one side, and another slice out of the other side, and you pretty nearly equalize the two sections. As to the height of the gun out of the water, Captain Coles has said, that he can make the turret-ship gun the same height out of the water as the broadside-ship gun.

Captain COLES: I think you will find that it is about the same.

Captain TYLER: It appears to be about the same on the diagram.

Admiral ROBINSON: The very principle we contend for is that the guns should be high, and not low.

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Captain TYLER: At all events, in this diagram it would appear the height is about the same; and as I said before, I do not see any reason why it should not be the same. If it is not so, it might be made so; but then there is no doubt this disadvantage, that the gun being withdrawn (and that is the principle of the turret-ship, that the gun is withdrawn) from the side of the vessel, it cannot certainly fire as directly upon the water as the broadside gun can.

Captain COLES: That gun can give seven degrees of depression, the same as the broadside.

Captain TYLER: It cannot possibly give the same as the broadside,

Captain COLES: Yes it can, it can be set to that angle of seven degrees.

Captain TYLER: I do not know what the angle is; at all events, if the gun comes a little within this point, it will fire upon the deck, that is obvious.

Captain COLES: No broadside can depress more than seven degrees.

The CHAIRMAN: You will have an opportunity of noticing the point in reply.

Captain TYLER: At all events it would appear, at first sight that the turret vessel would be a very uncomfortable vessel to go to sea in, as compared with the broadside vessel, there seems to be so very little room to move about in it. A great part of the narrow space is taken up by the turrets, and the remainder is unarmoured. Now the colour of the model struck me with the idea that, possibly, if a vessel of that description went into action, the first thing her enemies would endeavour to do would be to set fire to the wooden unarmoured part; and I apprehend, if the wooden unarmoured part were to be set in a blaze, it would be quite impossible to inhabit this turret-ship.

Captain COLES: This is all iron.

Captain TYLER: If that is all iron, it clearly will not burn, and my objection falls to the ground. Then it seems to me, with these turrets, two, or three, or four, as the case may be, it will be a very awkward thing indeed if a gun burst in a turret. Guns are liable to burst, and if a gun bursts in a broadside vessel it does a certain amount of damage, more or less, and the vessel is not disabled. But if a gun bursts in a turret, it becomes a very awkward thing indeed; at all events, that turret is disabled, and you have lost a half or one-third of your fighting power at once. Those are the principal objections that struck me, as I listened to this discussion; and I will not detain the meeting, not being a professional man, by any further remarks upon the subject.

Mr. BELL GALLOWAY: Mr. Chairman and Gentlemen, the subject under consideration is, as has already been stated, an all-important national one. It is a subject that has occupied my attention and study for about twelve years, and during that time I have been in correspondence with the Admiralty. My name is very well known there; and I am very happy to-night to meet the Controller of the Admiralty for the first time.

The CHAIRMAN: Will you kindly keep to the subject?

Mr. GALLOWAY: I beg to apologise. The subject-matter to-night is, whether is the turret principle or the broadside principle most valuable for the protection of our country? It has been properly said, and here I perfectly agree with the honourable gentleman, that each system has its advantages for particular purposes. In plain terms, I say, as a working man, we can do almost anything with two kinds of tools, but one is better adapted for the doing of work than the other may be. There is, however, a happy medium, and I contend for the medium thus. If we want, as I have said in another place, a perfect fighting ship, we shall be able best to attain that object by the combination of the two principles, namely, a fighting ship, part turret and part broadside. That can be done, and it might be well—and here I speak submissively—if the Admiralty would let but one of the old ships that has been sold, according to the statement made last night, at £2 16*s.* per ton, scarce the price of an old collier that is working between London and Newcastle—if but one of these ships could be placed at the disposal of Captain Coles and another party, who would gladly work with him, it would develope practically the truth of what I am now saying. I submit, and I speak respectfully in this assembly, that there is a consideration of the most paramount importance connected with our ships, besides the means of protection.

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What would be the position of a ship of war during an engagement? I put it thus, what would be the position of a ship of war during an engagement from the effect of shot striking those heavy armoured plates, and then, by concussion and vibration, starting the rivets. I submit that your ship would be nothing more or less than a coffin for every soul on board, and I say that there exist means of preventing such a catastrophe in the application of the cellular principle of construction of armour, which ought to have been applied ere we had come to this state of things. Then, again, what would be the position of our ships of war, during the first engagement from the effect of any one shot—(and there would be new fighting tactics)—disabling the progress of that ship, by disabling the action of your screw propeller or rudder? What would be the position of the ship then? It would be simply a target to be shot at. And then, again, is it not a strange anomaly that there are actually plans existing.—(Question). I know of no more vital question.

The CHAIRMAN: These are questions not raised in the paper. This is not discussing the paper.

Mr. GALLOWAY: Two minutes more, and I shall have done. In all places and under all circumstances I will bow to order; but whatever may be the opinion of gentlemen here with respect to questions, the vitality of every question consists in the effectiveness of the Navy, upon which hang the destinies of our country; that is the all important question. With this one question I will close my remarks: How is it, and why is it that we have a Navy which is deplored in high circles? Even Sir John Pakington, in the House, admitted that it was not in the state of efficiency in which it ought to be. Now if there be plans, why, in the name of common sense, justice, and humanity, are those plans not applied to save thousands of lives, and the honour of our country?

Captain HEATHORN, R.A.: I wish to say one thing, which I do not think anybody has before mentioned in connection with the turret system, and that is, that you get a great amount of top purchase and rear purchase in a turret for your working gear. We know, now that shot and cartridges are beyond a man's handling (from their very large size and weight), that mechanical arrangements for lifting them are necessary, and it is important to those who have to scheme out the working of heavy guns, to have strong purchases both above and abaft a gun, as rigid bearings for running in and out gear, as well as for shot-lifting. In the turret system the whole arrangement of guns and turret revolving together, these bearings are always in the same relative positions with the gun. I have been engaged in sketching out the interior workings of some turrets, and this has been one of my greatest considerations, viz., to get all the bearings for working heavy weights always in the same relative positions. It is not necessary for a turret embrasure to be low, although a turret may be low, because on any scheme of muzzle-pivoting there is no difficulty in so arranging that every degree of elevation in that gun can allow the body of the gun to be below the embrasure; and although to raise the gun to positions of depression, it will have to be a little above the level of the port, the gun will usually be lower in the turret than the horizontal line of the embrasure.

Captain COLES: I am sure it affords me the greatest pleasure to have to reply after the very courteous way in which I may say the turret system *has not been attacked*, for I think generally, almost the whole of the arguments used last night, on the main points are admitted. As regards Mr. Reed, no one is so much pleased as I am to find that whatever he may have been, and into that question I will not enter, he is now a supporter of the turret system; and that he may be considered after his speech of last night, to have finally joined the "innovators," as he honoured us by calling us. His position, no doubt, precluded him from any attack upon any of the main arguments addressed by me, to show the superior advantages of the turret system over the broadside, for heavy ordnance. I will refer very shortly to the incidental points touched on by Mr. Reed. But, first, let me tell him, as regards my British sailors in the diagram, they are correctly drawn, and measure 5 feet 8 inches in height, on a quarter of an inch scale, and that the illustration they afforded my argument, was equally fair at both ports. I anticipated such a remark from past experience, Mr. Reed having made the same remark with regard to that diagram of rolling in 1863, which, by the Admiral's re-

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port that I read last night, has only proved too true. I made both set of men exactly the same size. One would really have thought, from his criticisms on the height, that he, as a ship-builder, was not aware that the deck on which the sailor stands, was lower than the port-sill. As for the plating below water, I have not gone backwards in reducing that plating below water. I have shown that the low free-board will not roll a reduced quantity of armour out of water, and thus expose the unprotected part. Therefore to have added the additional quantity, would have been the surest bungling, if I may so call it. It would have been to make the country pay for an extra quantity of sheathing, to injure the qualities of the ship. At the same time, I should add in explanation, that the "Captain", has three feet less beam than the "Bellerophon;" and for that reason only requires somewhat less plating. As regards the comparative cost of the "Bellerophon" and the "Captain;" I will not go further into the Dockyard mystery of the charge for plant; for if Mr. Reed, with his official experience, thinks the mystery unfathomable, I am quite ready to put it down as one of those things which "no fellow can understand." At the same time, as the interest on contractors' plant must enter fully into the cost of the "Captain," I really do not see that the figures I have shown have been erroneous. It was £430,495, the cost of the "Bellerophon," (though the accounts are not made up, not complete,) and the cost of the "Captain," was £335,000. I stated, as you may remember, in both cases, that the accounts were not yet completed. As regards the statement, that the "Bellerophon" only had two guns:—what is stated in the Report is that the "Bellerophon" only fired two shot. Well, Mr. Reed states, and no doubt correctly, that she had but two guns, and fired one round from each. She might, of course, have fired the prescribed number of rounds from each of those guns, if it had been thought safe. Admiral Warden's Report says:—"We could "have opened all the main deck ports, but judging by the effect of opening only "five, it would have been to have washed the men away from the guns."

Mr. REED: Excuse me, that is not the "Bellerophon."

Captain COLES: It was with the "Lord Clyde;" therefore, the "Bellerophon" had apparently a great advantage, in this little broadside difficulty, in having, at all events, four-fifths of her ports, clearly closed against the water. As regards the relative power of stowing extra coal in the "Bellerophon" and "Captain," Mr. Reed says it is, at least, equal, or, if anything, greater in the "Bellerophon," than in the "Captain." But, according to the plan of accommodation and battery of the two ships, it may be proved, if time would admit, that this could not be so. It could be stowed in the "Captain"—on the deck below, between the two turrets—without interfering with the accommodation necessary for the complement of 400 men; or with the battery, or the trim of the ship, as it would be in the centre of the vessel. Whereas, in the "Bellerophon," it could not be stowed in the centre without blocking up her guns; nor at the ends, without interfering materially with the requisite accommodation for her complement of 556 men; or, with the trim of the ship; because you would have to stow it either before or abaft the battery. Having thus noticed those points to which Mr. Reed seemed to attach importance, I must add that on the general question between turrets and broadsides, they are comparatively unimportant. Assume for the sake of argument, that the "Bellerophon" is the very best broadside ship that money or skill can produce, and that she will at all times have an efficient supply of water-tight cartridges, of what use would she be against a good turret-ship, if she cannot open her ports with safety in a good swell? and if she is liable to have her fighting crew disabled by the entry of only one 300-pound shell through any one of her ports, into her square box? However, now that she is built, I trust she will be as successful as her designer can possibly desire, Now, as to the "Wyvern," which has been quoted as a turret-ship on this occasion in the Admiral's reports, I very fully stated in my lecture the reason why she should not be considered a sea-going turret-ship. I said, as it is, the "Wivern," without the requisite addition, has been used to disparage the favourable conclusions as to the turret system arrived at by both Admirals and it is curious that the only remark Mr. Reed made in apparent or partial disparagement of that system was founded upon that very "Wyvern," and upon the assumption of her being a fair representation of a sea-going turret-ship. I agree with Mr. Reed, that it is not fair to quote

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from a report only that which is in one's favour; and if I had admitted the "Wyvern" to be a reasonably fair representation of a sea-going turret ship, I should of course have quoted every word of the report which related to her. As I do not so consider her, and as early as 1864 wrote to the Secretary of the Admiralty to that effect, I think I was entitled without unfairness to read only such parts of the printed report as related to broadside ships, admitted to be good specimens of their respective classes, and to leave to others, if they thought it worth while to rest their defence of the broadside vessels, as Mr. Reed seemed inclined to do, upon the comparison with the "Wyvern." I think this also may answer Captain Scott upon that point. As regards the effects of a low freeboard upon rolling, Mr. Reed admits that up to a certain height the low freeboard has that effect. The only question between us, therefore, is one of degree. In the suggested comparison I made of the two vessels, you will remember that at the first they both rolled 20 degrees, their guns being assumed to be the same height above the water, and in that case the turret gun was not, and the broadside gun was, in the water. I think that is clearly shown. Then I assume the low free board would roll only 7 degrees to the broad side rolling 20 degrees. I assume that; it is part of my argument that the low freeboard rolls less, which is also partly admitted. Mr. Reed would admit that this will be true up to a certain height of freeboard. Here again the question between us is one of degree. Time will not admit of my answering every point, but I will try and answer a few. Captain Scott gave us a very interesting sketch of gun-carriages, and also of rolling and so on. With regard to the "Wyvern," I think that is already answered. With regard to the gun-carriages, he spoke of the exercise at some of these trials being made with old carriages. He should have stated that the gun-carriages in the "Royal Sovereign" were wooden carriages, and more or less defective; and, what is more, they were not fitted with the appliances which I had asked for, namely, the winches to run in and out. We heard the Controller of the Navy ably describe how necessary it was to have mechanical appliances to run the gun in and out. Now on this occasion, when these guns in the "Royal Sovereign" were fired, those winches were not applied, and they had the old carriages that had been condemned by Captain Osborn in 1864. But even then you see we fired at the rate of one round in 1 minute and 23 seconds. Now, Captain Scott quoted some other firing, and admitted that they did not fire at a mark. The report of Captain Key on this occasion goes on to say: "In both cases,"—the cases of the turret gun—a report upon the "Royal Sovereign," that is the double and single turret—"in both cases a small target was "fired at 1,000 yards distance, and good practice made." Now I contend that if Captain Scott's quotation was of a gun, not fired at a mark, but of quick firing, it was no criterion at all, for the very essence of the turret system is the power of taking aim, and the power of seeing your enemy. It is a fact, and has always been known, that in broadside ports it is very difficult to see the object, particularly when it is moving, and this difficulty accounts in a great degree for the slowness of firing on that occasion, when, as Admiral Warden says, it took him three-quarters of an hour to fire 15 rounds. The quick firing of the "Bellerophon's" guns, which Captain Scott mentioned, I think is also answered by the consideration that they were not fired at a mark. One thing mentioned by Captain Scott was the rushing of the sea into the port, and he explained that you could shut the port up; but if you shut the port up, as every gunner knows, and you only have the little hole for the rammer to go in and out of, we all know that it is a very much slower process to load; and not only that, but during the whole of that time, the captain of the gun can see nothing whatever. He has to wait until the port is up, to know if his enemy happens to be near. He has to search for his enemy; he has to go right and left of the port; and, as we know, it is very difficult to see the enemy at all; and you are obliged to send an order from the upper deck, and then very often turn your ship to find your enemy. Another thing was, that the gun-carriages upon which the experiments were made, referred to by Captain Scott, I believe were of iron, were they not?

Captain SCOTT: Certainly. As you have questioned me, I may state I have not quoted the "Royal Alfred's" firing, which was with iron carriages, but there was no increase of quickness over that from wooden carriages—none whatever in firing.

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Captain COLES: At all events those carriages were of iron. I now have the honour of answering the Controller of the Navy, and it is with great diffidence that I do answer an Officer who has done so much for the Navy, and who holds such a distinguished position in the Admiralty. I believe that one of the first things the Controller mentioned was, that in smooth water he considered the turret principle was the greatest weapon of offence and defence—that is, as long as the ship is steady, and that is the pith of the whole thing. I have contended, and I do contend, that low freeboard is what will enable you to keep the ship comparatively more steady than by any other means. That is the present question. It is a matter of degree to what extent you carry it. Another point the Controller of the Navy mentioned was, that the turret gun, not being high out of the water, waves 13 feet high, interposed between the gunner and the enemy, would prevent his seeing the enemy, or prevent a shot hitting the enemy; but as the "Bellerophon's" gun is not 13 feet out of the water, the same thing would occur with her.

Admiral ROBINSON: I stated the figure. I stated the height of the gun being 5 feet in one case, and the interposing wave 13 feet. If you wish to draw a comparison with the "Bellerophon"—

The CHAIRMAN: You did not hear that Captain Coles said, that the "Captain's" guns, which is a ship approximating in size to the "Bellerophon," are 11 feet 6 inches out of the water.

Admiral ROBINSON: I thought he was quoting what I had said.

Captain COLES: I was quoting the height of the wave. In fact, I think I had not explained myself. The wave is 13 feet high, so that any broadside ship, with a gun less than 13 feet out of water (and I do not think any broadside ships have their guns 13 feet out of the water)—any ship with a gun less than 13 feet out of the water would have such a wave interposed between the gun and the object. But with regard to a difference as to the height of the gun out of the water; I think it may have escaped the Controller's memory at the moment, he seems to think that our great difference of opinion was about the height out of the water of these turret-ships, but it will be found that I have proposed, and do propose, vessels of all descriptions and heights out of water. For instance, you will see here a high freeboard, and different ways of mounting turrets have been sent to the Admiralty. *Here* is a turret mounted on a pivot going down to the lower deck; *here* is a turret on a circular box, on purpose to give her a high freeboard. *Here* is a ship, the first sea-going ship drawn out by Mr. Barnaby, No. 4; she has a square box in the centre, on purpose to give a high freeboard. That ship's guns are higher than most ships, they were 13 feet out of water. That ship was proposed by me, and drawn out in the Controller's office in 1863. The "Royal Sovereign's" guns are 12 feet out of water. The "Naughty Child"—a vessel sent in in 1863—her guns were 10 feet out of water. The turret-ship designed in 1863 I have noticed. The "Captain" is 11 feet 6 inches out of water. So that it is a mere matter of degree how high you have your gun out of water, and, of course, your freeboard, it may be supposed, is governed by that. But it is not so in a turret-ship. You can have a low freeboard and a gun a great height out of the water, as much as 11 feet or even more. You have only, as I have explained, to slope the deck considerably, as you see there; I merely raise the turret a little, and get my gun higher. Instead of that, if you wish to get a gun higher out of water in a broadside ship, you have to increase the height of your broadside ship, and to increase all that extra weight. I have only to increase the height and the small weight of the cylinder of the turret. On this point, I think the Controller said we have not been able to come to any decision in these turret-ships. But I hope I may be allowed to say that, with all the various propositions which I have sent in from time to time, the Controller had a great many specimens before him, and it did not rest with me whether a ship of that sort was built or not; I had only to give my plans, and it rested with the Controller's department. I merely made suggestions. I did not prevent ships from being built, and therefore I cannot quite see that I have been the stopper to the sea-going ships, when I see all these different classes proposed by me. But, again, how is it, if I have been the stopper to building sea-going ships, how is it that sea-going turret-ships, built at private yards, have crossed the Atlantic, when

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we have not a sea-going ship in the Navy. Now, Gentlemen, a letter was put into my hand, which, if you will allow me, I will read, and I think it will be very interesting. It is written to me by an officer of distinction in the Peruvian Navy :—

"London, 1st May, 1867.

"Captain Coles, R.N.

"Sir—As you are giving a lecture on turret-ships, perhaps you would like to have "the following particulars of the turret-ship 'Huascar,' which was built under my "direction for the Peruvian Government, by Messrs. Laird Brothers, and taken out "by me to Peru.

"In the report addressed by Commander Garcia, commanding officer of the Peru- "vian ironclad frigate 'Independencia,' to the head department of the Navy, on his "voyage from Europe to the Pacific, in convoy with my ship the 'Huascar' (carry- "ing the Commodore's flag) and the wooden corvette 'America,' the following extract "from that report is to be found inserted in the newspaper *El Comercio*, dated the "24th of August, 1866 :—

"'On our arrival to the Pacific, the barometer began to fall with admirable "'rapidity, and as it was blowing hard from the N.W., we did not doubt we were "'going to meet one of those heavy gales so frequent in those latitudes. The "'weather, until then cloudy and rainy, began to appear stormy on the 30th and "'31st of May. This last day we met a very strong northern, which, changing "'suddenly into N.W., became a violent and protracted storm, accompanied with "'hurricane squalls. As it was impossible, under these circumstances, to steer "'the ship's course, mainly by the terrible broadside swell which was rising, we "'were lying to with fore staysail and trysails, steaming under very easy steam, "'to enable us to put the bows to the sea. Although the storm's strength did "'not allow us to carry more sail than that which we carried, we were obliged to "'set the topsails under the close reef, as the only remedy to check the extra- "'ordinary rolling of the ship, which exceeded in many cases 30° on each "'side.'

"Notwithstanding losing the convoy of the 'Independencia' and the 'America,' I "had so much confidence in the 'Huascar' that I made my direct course for Chiloe, "and arrived there at 9 A.M. on 6th June, the 'America' the next day at 11 A.M., "and the 'Independencia' at 2 P.M. the same day, that is, 29 hours after the "'Huascar.'

"I may add that the 'Huascar' is 1100 tons, carrying two 12½-ton guns in her "turret, and two 40-pounders aft on deck, and that she was very buoyant and a good "sea-boat. The 'Independencia' is a broadside box ironclad, of upwards of 2,000 "tons and 550-horse power, not carrying any gun heavier than 150-pounders.

"I am, Sir,

"Your obedient servant,

"JOSE M. SALCEDO.

"P.S.—We left Chiloe on the 11th June for Valparaiso, and met the same night "a severe gale, when we again parted company with the 'Independencia,' but "arrived at Valparaiso on the 15th, the 'Independencia' not arriving until the next "day."

That was the first ironclad ship that went across the Atlantic, and that gentleman, I believe, is present here to-night, and I have no doubt he will tell you, if you wish it, with his own mouth, that that vessel was a beautiful little sea boat; her deck was six feet out of the water. So much for the sea-going qualities of turret-ships. The Controller says that the turret-gun is unprotected between decks; that is that the turret is only protected by the ship's side. That is one of my very great arguments in favour of low freeboard. Suppose, for instance, that a ship's side is ten feet out of water, and it is covered with six-inch iron, if you reduce that portion to five feet, it is evident you can double the iron on that portion which would make it one foot of iron. So that if that is the case in low freeboard, that is another great reason why you should adopt it. And again, if the turret-guns are unpro-

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tected, are not the guns of a broadside-ship much more unprotected, where you have the very much higher side, and, as we find, a very much thinner side in proportion, with all these numerous port-holes for the entry of shell, and, I think, you all know that the entry of one shell in such a casemated battery as the "Bellerophon" would be quite sufficient to put that ship *hors de combat*; at all events for some time—shells with 12-pound charges. Another objection was that the all-round fire of the "Captain" had been sacrificed. It has been sacrificed to a certain point. That is, we can fire the 600-pounder within six degrees of the line of the keel. Now, is there any other ship in the service that could fire the 300-pounder at the same angle? They may fire their smaller guns by poking them out of the port-holes in the bow, but they will not be able to fight those guns steaming against a head sea, whereas the gun in the turret-ship being well placed, can, when steaming that ship against a head sea, still be firing nearly right ahead. I think, gentlemen, nothing can be more satisfactory, or more kind, than what the Controller has said. There is, however, one point more. It was mentioned that a gun bursting in a turret would do very great damage, but I must remind you, that the gun or a shell bursting, or anything bursting in a turret, is just where it would have the advantage over a broadside-ship. If the gun bursts in a broadside-ship it creates a panic on the whole of that deck, and may not only kill the crew of that gun, but the crew of the gun next to it; whereas a gun bursting in a turret is localised to that particular point, to that one turret. Perhaps if the gun burst here, you would lose the power of one turret of two guns, but if a gun burst on that deck most likely the whole deck would be put *hors de combat*, particularly with these 40-pound charges. In fact that is one of the great points that are pointed out as an advantage in the turret by Captain Powell in his report of 1861. I will not trouble you by reading that report, as I think I read it last night, but it says that one of the great advantages is, that if a shell burst in the turret, or a gun burst, it would be localised to that particular turret. There is yet one other point that I will refer to. The Controller said, and I was very glad indeed to hear it, that he had always been a great advocate of the turret, and is so now, for special purposes. Well, Gentlemen, it has given me the greatest pleasure, nothing could have been more satisfactory, for what did I say last night? I think you will find that I particularly pointed out that, as a rule, special vessels must be built for special purposes where armour is involved, but that the turn-table and shield which combine to form my turrets, admit of war ships being constructed which can serve for more general purposes than the broadside principle admits of. "For instance, vessels capable of the defence of our shores," that is the very first thing, I think, the Controller of the Navy was pleased to grant to the turret-system, "or colonies, fit for the close attack "of an enemy's strongholds, carrying the heaviest cannon that we can manufacture, "and yet capable of crossing the widest ocean, can only to-day be found in existing "vessels with a very low freeboard and turrets." I think upon that point we may consider that we have no longer the slightest difference of opinion. I do not know whether there are any other particular points which I may be called upon, or which it is necessary to answer, but I think I have touched generally upon all. I can only conclude by saying, that this lecture and discussion, however much trouble they may have caused me, have been an immense pleasure to me, not only because I consider that, to a very great extent, the turret principle is admitted to be right, but I have found, and am happy to see, that there is such a great disposition and such a great effort that our Navy should benefit by it. It only remains with me to thank you, and to thank the Controller, and all of those gentlemen who have contributed to the information which I have gained, and which it has been my purpose to gain in laying my views before others. I still think and feel, as I say, that for special purposes you must have different vessels. As I mentioned last night, those vessels with very low freeboard, whose sails were left out, are not meant for sailing, they are only meant for steam-power, and with regard to the whole of those vessels, my opinions are very much strengthened by what I have heard. I hope, gentlemen, that we shall not only hear of other vessels crossing the Atlantic, but that we shall soon have turret-ships to do the same.

A VISITOR: I am requested by Capt. Salcedo, as he does not understand English

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very well, to translate for him, and he will have much pleasure in answering any question put to him about the "Huascar."

The CHAIRMAN: Can you say what is the thickness of the armour-plating?

A VISITOR: Four inches and a-half armour-plating.

The CHAIRMAN: What was the size of the vessel?

Captain COLES: I can give you all the information.

The CHAIRMAN: At this late hour, perhaps it is hardly necessary for me to add anything. I should like to have made some remarks, but at this late hour it is not desirable. It must be remembered that the condition of the turret and broadside question is very different now to what it was when it was enunciated by Captain Coles, and I must say that I think the present position of the matter is very much owing to the persistent and talented way in which he has prosecuted his work under very great disadvantages. He has already stated to you that we have not got a turret-vessel in his estimation such as would afford us the information that we really require to enable us to come to anything like a satisfactory conclusion as to the relative merits of the two systems, and I do think that the burden that has been laid upon the "Wyvern" is too great, and is not at all such as would warrant any comparison whatever between her and "Bellerophon." She is a very small ship; you cannot make any real comparison, unless the two ships are similar in size. It is quite out of the question. It is quite clear the main principle of the turret system, that is, the idea that Capt. Coles has, that a low freeboard will produce an easy vessel, a vessel that would not roll much, is admitted by Mr. Reed very justly. I quite endorse his opinion that it would have that effect. I also endorse his opinion that if the freeboard were high, in proportion as it were high, it would do away with the advantage which had been originally contemplated by Captain Coles, and the vessel would be in that proportion uneasy. Therefore the statement of the Admiral that if the vessels had had their guns a certain height in the turret-ship that they would have had great advantages over the broadside ships — Captain Scott did not quote correctly—I beg his pardon, he quoted correctly, but I do not think he interpreted it correctly, because the latter clause of the quotation clearly implied that the Admiral was speaking of the height of the gun, and not the height of the freeboard. Now as the principle of the turret system is to have a low freeboard for the purpose of getting an easy ship, it would have been destroyed by having a high one; therefore, if the gun is high, that is all that is really wanted. You have a high gun, a low freeboard, and you get an easy ship. Now, I believe, a combination of the two systems would make a far better one. I am quite sure that the old system of French ships was a very wise system. It was discontinued in great measure because of the necessity of having more space on the decks for larger guns. Now you are introducing that which undoubtedly is due to Captain Coles, and that is the turn-table, and that practically is a long approach towards his system, and certainly he is entitled to the full and undoubted credit of that. I do not think that you could have fought the large guns with advantage, or with safety if you did not use the turn-table. Therefore that is of very great importance, and I do think the fact of his having introduced the turret and the turn-table, has led very much to a more early adoption of large guns into the Navy. I quite feel, too, that the discussion on the turret system will lead to what I believe to be essential in easy ships, and that is, narrower ships than we have. With respect to the uneasiness and the difficulty of those ships firing their guns, Captain Scott says, it was a defect of the carriages, but why were the carriages so defective? Because the sudden, the rapid, and extensive motions of the ships, required more than ordinary skill and care of mechanical construction. With respect to the construction of those carriages, I say, the very failure of the carriages, while it obliges you to get a more effective carriage, also ought to point out a defect in the ship, either in the stowage arrangement, or construction, or form, I cannot say which. It is, no doubt, a very complex question, and one not easily dealt with, but as attention does overcome difficulties that ought to be overcome, it is essential that it should be overcome, and I do not believe that there is any insuperable difficulty in overcoming it. There are advantages in the turret system which I think are very decided with respect to the gun and to pointing of the gun,

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and I must say until this discussion took place, I was not aware it had so many advantages as it has. Of course we are not prepared to say, that it has perhaps the extreme advantages claimed for it by Captain Coles, or that the broadside system has the extreme disadvantages. However, I accept, and I think we all agree to that, that there are specialties, and you must have particular ships for them. You cannot say you will have all turrets, and you cannot have all broadsides. But what is really wanted is, that we shall all put our heads together and agree to work together, as we have a common object, a common end, a common interest, and each accepting opinions and ideas one from the other, borrowing not stealing, giving credit where credit is due, and honor where honor is due. I think you will allow me to return your thanks to Captain Coles for his very clever, and very ingenious principle, and I am sure if he had not had a more than ordinary mechanical genius he could not have overcome the difficulties that he has had to contend with, and he would not have brought it to the perfection he has. On the other hand, we must give credit to the Departments who are going in the direction of recognizing the principle distinctly, and of frankly avowing the value of that principle, and are adopting it so far as they conceive consistent, and of course every man in a position of trust and responsibility, must exercise his own judgment, he must not accept another man's judgment. He is responsible, and of course as he is responsible, he must exercise his own judgment in the matter. I have much pleasure, Captain Coles, in returning you the thanks of the meeting.

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Evening Meeting.

Monday, May 13th, 1867.

ADMIRAL THE RIGHT HON. THE EARL OF SHREWSBURY AND TALBOT, C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between May 6th and May 13th, 1867.

ANNUAL.

Barton, William, Capt., late Gr. Gds.
Keyes, C. P., C.B., Lt.-Col. Mad. Staff Corps, Commt., 1st Punjab Infy. 1*l.*
Ommanney, M. F., Lieut. R.E.
Fosbery, W. T. E., Capt. h.-p., 77th Regt. 1*l.*
St. Clair, Hon. Archibald, Comr. R.N. 1*l.*

THE COMBINED "END-ON" AND BROADSIDE PRINCIPLE.

By Captain T. E. SYMONDS, R.N.

BEFORE commencing my paper, I have to express my regret to hear that Captain Coles will not be present this evening. I informed him, as did also the Secretary, of my intention of reading this paper "On the Combined *End-on and Broadside Principle*," as opposed to *the Turret Principle*, and I had hoped to have had the pleasure of seeing him here this evening to reply to any criticisms I might make on his views.

There are, I believe, few accounts of Naval Battles on record, whether between fleets, single ships, or ships and land defences, in which the value of end-on fire has not been more or less apparent; and there are few Naval Officers who have been employed in chasing pirates—slavers—or in battles with a more powerful enemy, who have not felt the great practical disadvantage of not having a gun always ready to fire clear of obstructions, *end-on*, either ahead or astern.

The escape of many a chase, and the history of many a disaster, may be attributed to the absence of this great desideratum in war vessels of every class. It was severely felt in the old war, especially when acting in-shore against gun-boats and land batteries, for instance

*** The diagrams and models referred to may be seen at No. 10, Adam Street, Adelphi, London.—T. E. S.

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the "Dictator," Captain Stewart, and the "Melpomene," Captain Warren, in action with the Danes, and there have been several illustrations of it in more recent operations in the Russian and Chinese wars; one instance with which we are all familiar is the case of the "Teazer," in the attack on Lagos, when yawing to bring her guns to bear, she was swept out of her course, and took the ground.

That such an opinion does exist was abundantly testified by the audience present at the reading of Captain Scott's paper; on which occasion it also appeared that the advances made in the direction of "end-on" firing were unknown, and consequently not appreciated. I therefore offered to read this paper on the subject, preferring that method of introducing to the notice of the Institution some inventions of my own, to importing them into a discussion on another man's views.

Lest it may be supposed by those unacquainted with my past advocacy of the combined "end-on and broadside system," that the opinions I now advance are based on recently-conceived notions, I hope to be pardoned for referring somewhat frequently to my former papers on the same subject, read both here and at the Institution of Naval Architects. These will establish the originality of my views, and prove that which I am very desirous should be understood from the outset, namely, that although I have been a constant and firm supporter of the broadside type of ship for sea-going purposes, I repudiate all partizanship, and never denied that the turret system might be applied in special cases with advantage; being actuated solely by that sentiment which I have invariably felt and expressed, viz., the desire of benefiting my profession and advancing the naval power of my country, to whose authorities my plans and suggestions have been almost exclusively addressed. (For extract from my paper of 1863, see below*). It is a source of great satisfaction to me to find that such opinions have been borne out in practice, and that objections which I have persistently raised to the so-called sea-going turret-ships have been confirmed even by the gallant inventor of that system, who has very materially altered his position.

The type he first advocated was said to possess an "all-round fire," the strong point much dwelt upon by him and all supporters of the system being the bow and stern attack; this, however, has disappeared, not only in his own ship, the "Captain," but in every other turret-vessel constructed to cross the ocean in which the "poop" and "forecastle" have been added as indispensable. End-on fire being thus impossible, most of the arguments adduced by him in condemnation of broadside batteries recoil upon himself, and the system, as applied to sea-going ships, may be fairly said to have retrograded since its first introduction.

* "For my own part I sincerely hope, both for the good of the country as well as for Captain Coles' sake, that his shields may prove an entire success, although I do not agree with him in condemning all broadside ships, and claiming for the cupola system all those advantages he believes it to possess, especially for sea-going ships. In any observations I may make I distinctly repudiate all idea of antagonism to his or any other particular system, my object being the benefit of the public service."—See Journal Royal United Service Institution, vol. vii., p. 315.

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I believe that the apparent simplicity—I may say nakedness—of a turret ship, as first introduced to our notice, was that which captivated; no one could look at the early representations of Captain Coles' cupola ships without being struck by their warlike and wicked appearance; like a pugilist or a game cock, they appeared divested of everything that could interfere with their work, presenting the smallest possible object to an adversary, and no doubt well fitted for the duties they were originally intended to perform, namely, *harbour* defence, and *operating* on *inland seas* and *rivers*.

In seeking to extend his sphere of action to sea-going ships the simplicity has vanished; and in the struggle to make turret-vessels moderately seaworthy, Captain Coles is compelled to introduce to some extent the very features he has so constantly condemned in broadside ships, the proportions as regards a target being similar to those of ordinary ships. How far they will be sea-worthy is at present mere conjecture, but judging from those specimens that have been tried, I have very great doubts of their ultimate success.

Those who have served in brigs and vessels of similarly low freeboard, which from their lightness and consequent buoyancy could not fail to make better weather than ships heavily armoured, and who have seen what took place when a port was stove in, may readily conceive the effect that will be produced by the sea breaching between the turrets under the hurricane deck, which deck, by-the-bye, is after all a mere apology for a platform on which to work a frigate's sails, and to carry out those drills and exercises imperative for the proper organization of a ship's crew. Place the "Captain" in the same position as those broadside ships, the shortcomings of which Captain Coles was so severe upon, would not a wave run up the glacis of the low deck, and if not filling the turret, would it not certainly necessitate the use of waterproof cartridges as much as in the broadside ports?

Upon these points I shall refer to my paper on Steering and Manœuvring Ships, &c., read here May 18th, 1863. (Vide "Journal of the Royal United Service Institution," vol. vii., page 317.)

I am of opinion that Captain Coles claims too much for the sea-going qualities of his ships, which are as yet untried. They are low in the water as compared with ordinary ships—the actual side of the ship shown in his diagram being only 7ft. 8in. above the water-line, the whole defence from a sea being the flying bulwarks or flaps, the efficiency of which to resist a sea I doubt. A first-class frigate often ships a heavy sea over all—her side being some 13 feet higher than the top of his moveable gunwale. Such a sea would clear a turret-ship's decks. I think, therefore, until we have arrived at some method of construction which gives us qualities infinitely superior to those we at present possess, that we cannot rely on such a ship for laying-to safely in a heavy sea. Nor can we dispense with an upper deck, on which a sufficient proportion of boats and spars can be stowed with safety, and with stout bulwarks to protect them.

At the period when Captain Coles first introduced his system, the broadside ship was a very different affair to some of those since built, and more especially to many now building, in which "end-on" fire has been introduced to some extent.—Vide diagram, No. 3, Plate xxxviii.

The following table gives a list of the principal armour-clad ships in which bow guns have been fitted for right ahead fire:—

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	Deck upon which the guns are placed.	No. of guns.	Height of Sill above load-line.
			ft. in.
Minotaur	Upper deck	2	19 6
Agincourt	ditto	2	19 6
Northumberland	ditto	2	19 11
Hector	ditto	2	17 6
Valiant	ditto	2	17 6
Royal Alfred	Main deck	2	10 9
Lord Clyde	Upper deck	2	19 0
	Main deck	2	11 6
Lord Warden	Upper deck	1	18 7
	Main deck	2	11 1
Bellerophon	Main deck	2	10 2
Pallas	ditto	1 ahead, and 2 at 14°	10 6
Monarch	Upper deck	1	16 7
Hercules	Main deck	1	13 9

The difficulty of working heavy guns on the broadside has been overcome: and Captain Palliser's invention has added so materially to the power of the present ordnance, as to render it a very great question whether we shall ever require a heavier gun than the present 300-pounder for sea-going purposes, in which case the value of the turret system becomes still more doubtful. In weighing the question between the broadside and turret armament, we should assume the calibre of the gun to be the same in both cases until it be proved, firstly, that a reliable 600-pounder can be made for service at sea; and secondly, that when made, a broadside ship cannot carry it. There is no more reason at present to doubt that this can be done than there was four years ago, when it was stated to be impossible to work 300-pounders on the broadside. Granting this view to be correct, in what consists the superiority of a turret ship's broadside, reduced 50 per cent. of its assumed weight? I can state with the utmost confidence that a broadside ship will carry not only as many guns on *each* broadside, of the same weight as those carried in the turrets, but she will carry *two additional*. It must also be remembered that when a turret ship is engaged on both sides, she can only fire half her battery at each adversary, whilst the broadside vessel brings her full number to bear on either side.

Without regard to the position of the guns, the "Bellerophon" and the "Captain" will exemplify this comparison.

I am very much disposed to lean to the opinion of practical men who have been under fire during the American war, that the rapid concentrated fire of many guns, whether against ships or forts, will be far more effective than slow discharges from concentrated armaments; and when viewing the various duties that ships of all classes have to perform, not excepting the occasional landing of their guns,

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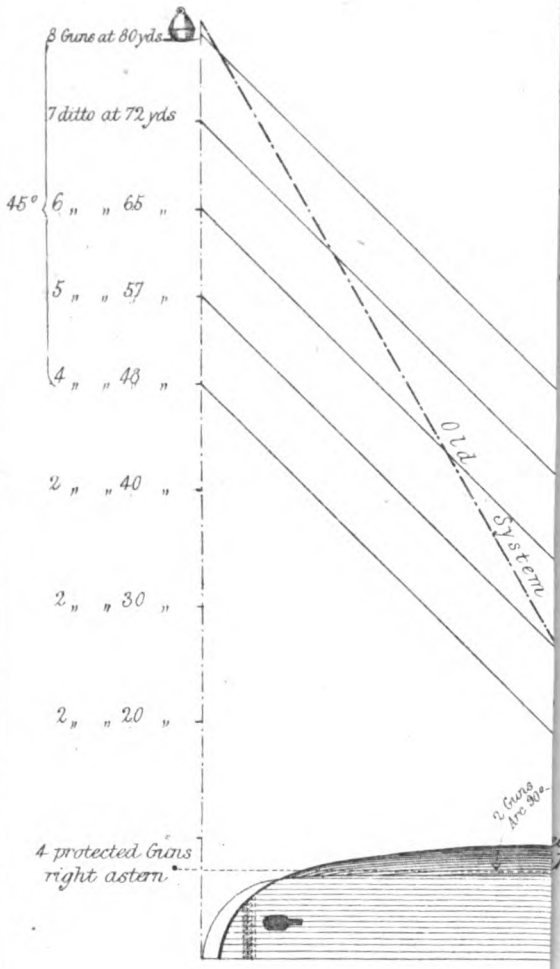

J. Jobbins

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I think an additional argument will be found for many effective guns of smaller calibre rather than for a few very heavy ones.

It appears to me as though the broadside system has advanced in the same ratio that the turret has retrograded; each year has developed some new feature; the "square box" (a term often applied in derision of the "central battery," commenced in the "Warrior," and continued, I think wisely, in later ships) has had its corners knocked off by repeated broadsides from turret guns, and by indenting the sides a fixed semi-turret is formed at either end, from which four of the heaviest guns may be worked, end-on, through an arc of 90°, as shown in diagram No. 1 (Plate xxxvii), not shifted from port to port, as was the case when Captain Coles read his first paper. These guns are at such a distance from stem and stern as will enable them to be carried without prejudice to the sea-going qualities or speed of the ship, and fought end-on in the heaviest weather. The distance of these guns from each end of the ship under notice is about 90 feet, being nearly the same as that of the "Captain's" turrets, the weight of which, however, at those points is much greater than the bulkheads in my system. No valid reason can be assigned why even a 600-pounder should not be worked in ports so placed, when on a turn-table; they being retired several feet from the side, the weight is centralized, and the muzzle of the gun is virtually higher out of the water.

Particulars and Performance of "Bolivar."

The performance of the "Bolivar," an unprotected twin screw vessel, of 830 tons, 230 feet long, 27 feet beam, 10 feet draught, built and engined by Messrs. Dudgeon, converted and fitted out by me for the Venezuelan Government, as an armed transport, with "indented sides," is perhaps the best illustration extant, of the practicability of that system: proving not only that guns so placed can be worked effectively at a high speed, with a head or beam sea, in a vessel deeply laden, the muzzles of whose guns were only 7 feet 6 inches above the water-line, in an indent of 4 feet, but that such an arrangement of "end-on" armament can be fitted in the course of a few weeks to a comparatively small, sharp, narrow, high speed vessel, of ordinary construction, a trifling alteration in the superstructure only being required, to carry the heaviest guns *under a deck*, which is impossible in such a vessel by any other method. It will be seen by referring to the diagram, No. 2 (Plate xxxviii), that the "indents," which are 70 feet from the stem and stern, are so situated in the body of the vessel as to prevent overweighting the extremities, the flare of the bow practically throwing the wave clear of the indented ports, which were thus enabled to be kept open in almost all weathers.

Considering that this little vessel attained a sea-speed of 15 knots, was armed with 70-pounder rifled guns and 24-pounder howitzers (might have carried 100-pounders with the same ease), with guns to fire within 10° of the keel (they might be fired at 5° with equal facility), propelled by twin screws, by means of which her guns

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were pointed with extreme accuracy; presenting an end-on target to an enemy of only 27 feet base (only 2 feet in excess of the diameter of the turret), and possessing a decked freeboard of 15 feet, under which there was the most perfect accommodation for a crew of 200 men, and capable of transporting 750 troops 3,000 miles on a 10 feet 6 inches draught of water; I think I may say that she is a very formidable vessel, and be permitted to ask how such results could be attained with a "turret" arrangement?*

I have peculiar satisfaction in referring to an extract from a letter received from the Captain of this ship confirming the above, as well as the statements I made in the years 1862 and 1863, in papers read at this Institution, on the advantages of the twin-screw system, for manœuvring ships with "broadside" and "end-on" batteries, a subject I have persistently advocated, which although condemned at first, is now being generally adopted, not only in "broadside" but in "turret" ships, thus proving that system is considered imperfect without them;—in fact since end-on fire has been established they are more necessary in the turret than the broadside.

Captain of "Bolivar's" Letter.

"We had a splendid opportunity of proving the advantages of twin screws in "handling a ship in a crowded anchorage. When about to leave the inner "anchorage at Falmouth, we had a steamer close astern of us, a vessel ahead, and "one on each beam, and no room between the shore and these vessels to permit of "our going between it and them; at the same time there was a strong gale blowing "to which we were riding: when the anchor was tripped, the engines were started, "one ahead, the other astern, and the ship turned exactly in her own length without "drifting a foot to leeward during the operation. In performing the evolution it is "perfectly unnecessary to work the engines at more than 'very easy!' The ship "performed splendidly against the south-west gale which prevailed for two days "after our leaving Falmouth. There is no doubt that the twin screws are most "successful in forcing a ship against a heavy head sea and wind. We had another "proof of their superiority in the passage to Madeira—the port engine got a heated "bearing. I offered the engineer to stop it. He said that reducing the number of "revolutions would be sufficient; he, therefore, reduced the revolutions of that "engine down to twenty-five, and kept the other up to eighty. During the time of "the bearing cooling our speed was reduced hardly two knots, and hardly any effect "was noticed in the steering; this is a decided advantage. In picking up a snug "berth among shipping, or in mooring or unmooring with steam up, the twin screws "are invaluable, and lighten the labour immensely. We took a turn out of our "hawse when shifting berth to the quarantine anchorage, simply by turning the "ship right round with the screws. You know what work clearing hawse is, and "can, therefore, imagine how the usually tedious operation was simplified. The "indented sides are without doubt admirable, and in the heaviest weather have been "entirely free from any lodgment of water, and we were enabled to make excellent "practice with the guns."

The "Pallas" is also fitted on this principle, but being a wooden frigate, and the plan having been adopted subsequent to her launch,

* The advantage of this method of armament in transports is very obvious even in this converted ship, especially when the decks are crowded with troops or cabins. The bow or stern guns in the indented ports having an arc of training of from 65° to 70°, thus obviating the necessity of transporting them from port to port.—T.E.S.

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the conversion has not been so perfect as in the "Bolivar," which is an iron vessel; the results attained in this ship, however, are also very satisfactory; I will now read an extract, from a letter recently received from an Officer of the "Pallas."

Extract of Letter from Officer of "Pallas."

"The more I see of the plan of firing from the bow and quarter battery ports, the "more I like it, and the more formidable does it make a ship appear in my eyes. "The other day we went out for gunnery practice, and fired at a mark against a high "cliff; and steaming quietly round in a circle, we fired from the broadside and bow "and quarter battery ports with great effect, and could have fired five guns ahead or "astern nearly in a line with the keel if we had liked—three of them quite, and the "battery guns only 14°, from the fore and aft line.

"It appears to me that the larger the ship, the more important it is to have the "indented sides; and in a ship like the 'Lord Clyde,' with guns on both decks, "really her strongest points of attack and defence would be 'end-on' if she had the "indented sides."

The "Research," originally fitted with the gate bulwark, has been also altered to this plan with very great advantage, both as a fighting and a sea-going ship, and it has added very materially to her accommodation and the comfort of her crew. Many of our new ships are being built on this system (vide Diagram No. 3, Plate xxxviii).

Distinction between Symonds' and Coles' End-on Fire.

Having thus described the method by which I attain end-on firing, I will now call your attention to the distinction between the power of firing "end-on" possessed by my system and that claimed for the turret. In mine, when constructed for the purpose, *not altered*, it is practically *right ahead* or *astern*—as in diagram No. 1; no need of yawing even half a point, four guns firing right ahead or astern *clear of every thing* at any angle of elevation or depression that the carriage will admit, whether rolling under steam or heeling under canvas; whereas the smallest angle at which the chase-gun of the "Captain" can be fired, in a horizontal line, is theoretically 6° (vide Plate xl, diagrams X, Y, Z); but we must bear in mind that *that gun is from the after-turret* (the fore-turret being blocked to 23° by the top-gallant fore-castle), the shot having to pass over 156 feet of deck, between the legs of the tripods which converge, topmast backstays, with such gear and obstructions on that deck, necessary to a sea-going ship, no matter of what description.

I think, it will be admitted, that this is rather close shaving, even under the most favourable circumstances in daylight, but what it will be on a dark night with the ship rolling and pitching (and even turret-ships will and do roll and pitch), perhaps short of coal, heeling over under canvas, or the deck and turrets enveloped by smoke or even fog, I do not think it will require a very imaginative person to predict. I have no hesitation in saying it will be impossible, and that if Captain Coles relies on this gun for firing "end-on," he will meet

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with disappointment, as a consideration of the diagrams referred to, showing the line of a shot from the "Captain's" after-turret, will clearly point out. I am disposed to agree with Mr. Robert Napier, whose letter appears in Admiral Halsted's appeal to the Parliament of 1866, when he says,—"I do not fear the enemy's shot, so much as the "risk of a shot from the turrets themselves when engaged against "an enemy!"

In proof of the foregoing, I refer you to diagrams X, Y, and Z, (Plate xl); X being the plan of the upper deck of the "Captain;" Y being a transverse section indicated by the line A B in X. These diagrams illustrate the limit of horizontal fire from the *outer gun of the after-turret*, in the direction marked C, with the ship rolling 11°, this direction being at 6° from the fore and aft line, the angle claimed by Captain Coles. It will be observed that the slightest divergence would strike the bulkhead of the compartment shown amidships, or the foremost tripod leg; should the inner-gun be fired by mistake in the heat of action, the result would be fatal. Diagram Z, is also a plan of the turret-deck, showing that a shot fired horizontally from the outer guns in the fore and after turret, in a direction of 6° with the fore and aft line, would strike the deck, supposing the ship to have rolled through an angle of 7°, with her head or stern lifted by the sea to an angle of 2°; these points are marked *d* in the diagram. In this case a very moderate angle is assumed in both instances, yet it will be seen that it would be impossible to fire on the top of the rolling motion, even at that small angle. Apart from the foregoing I conceive the difficulties, pointed out with horizontal fire, will be increased when firing at great elevation, and I also think it worthy of remark that the tripod legs interfere materially with the line of fire from both turrets in many directions. I have always understood that the object of this invention was to avoid such interruption to the all-round fire so constantly insisted upon.

Now, I submit, that contrasting the difficulties that have been pourtrayed in this most approved example of a sea-going turret-ship, with the simplicity and practicability of my system, that until some more substantial advantage has been proved than appears on the face of it now, we should not only suspend our judgment, but hesitate before we embark too largely in sea-going turret-ships, no matter how confident its advocates may be, or how specious the arguments they employ.

Assuming that it *is* possible for the after-turret gun to fire effectively at 6° with the keel, as claimed; in doing so let us see the size of the target exposed, as compared with an opponent armed on my system. To effect this object the turret-ship must be yawed half a point, thus exposing the whole of her side; whereas if that opponent has guns firing right ahead, the extreme width of target exposed by her would be less than half her beam, the inclined face represented by the bow, say at an angle of 25°, would be a much more difficult object to pierce. Moreover, admitting the turret-ship to have 600-pounders, and her opponent four 300-pounders "end-on" guns, the preponderance of metal would be 600 pounds in favour of the "end-on" ship.

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with this further difference, viz., that in any case the fire from the turret must be necessarily extremely slow and uncertain for the reasons stated, whereas from her opponent, there being *no obstructions or necessity for yawing*, the fire will be rapid and uninterrupted. Diagram No. 5, Plate xxxviii, illustrates the above.

Immunity of Turrets from danger.

Captain Coles' claim of immunity from damage for his turrets on account of their glancing properties cannot be substantiated, especially when engaging at a considerable angle with a broadside enemy; the turrets, when of such dimensions as the "Captain's," would *always* present a dead flat of nearly 10 feet wide by 7 or 8 in height; at a moderate range such a target would be struck by almost every shot, and always at right angles, for no matter in what direction the enemy may be, this dead flat will always be opposed to his guns; thus in the case I quote, the turret would be in a worse position than the flat side, which could only be struck at right angles when the enemy was exactly abeam. Now, referring to the diagram No. 4 (Plate xxxviii), which is a scale drawing of the "Captain's" turret, it will be seen that two ports are pierced within 5 feet of one another in the middle of the said dead flat or target, which conveys to my mind a structural weakness not to be found in the latest broadside ports (which are from 12 to 15 feet apart, and not of necessity so much larger than a turret's, as shown in Captain Coles' clever transparency on a late occasion), that weakness being increased by the bevelling of the ports in the turret, which is certainly equal to, if not exceeding, that required in the ordinary broadside ports. My port for a 300-pounder is 2 feet 4 inches by 3 feet 10 inches; the turret port being 2 feet 2 inches by 3 feet 7 inches.

Shell exploding in Battery and Turret.

Much stress was laid by Captain Coles on the disastrous effect that must necessarily be produced in the "Bellerophon's" battery by the explosion of a large shell, yet almost ignoring the possibility of such an event taking place in a turret in consequence of its small ports, contending that the result would amount to total annihilation of the battery, whereas the turret was to escape scot free. Now, it appears to me, that such an argument is untenable, for as before stated, the turret has two port holes within 5 feet of each other, representing a larger area, either being nearly as large as my port; and presenting two chances to one for a shell to enter. If a shell should perchance enter and explode in so confined a space, or if a gun should burst—neither event being improbable—what would become of the whole structure and its contents? There can be but one answer—utterly destroyed, and the ship, say the "Captain," deprived of *half her armament at one blow without possibility of repair.* I contend from our experience of the effect of shells in crowded batteries, that

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neither the loss of life, nor destruction of material could be so certain and general as Captain Coles would have us believe, in a space 100 feet by 56 feet, having many hatchways and ports to facilitate the escape of the exploded gas, added to numerous obstructions on the deck, nor would the disaster be so irreparable as in the other case.

There is one point in the history of turrets, which has not hitherto been disposed of to my satisfaction, and which to my surprise was not decided during the experiments on the turrets of the Royal Sovereign: I refer to the effect produced on the training gear of the turret when revolving, by the impact of heavy missiles. I believe that the effect of a blow on such a structure in motion would be very different to that when stationary; the force of that blow being the weight and velocity of the projectile multiplied into the weight and velocity of the turret itself, which would represent such an accession of force as must doubtless have a much greater effect on the mechanism of the turret than when it is at rest: until such an experiment has been made I shall not be satisfied of immunity from danger on that point, bearing in mind, that the turret of the "Rolf Kraake," when in motion, was perceptibly influenced by the impact of shot from 9-pounder guns; and also that the official reports from America show, that the turrets of many of the Monitors were not unfrequently stopped by shot, and deprived of offensive power. All shot struck the "Royal Sovereign's" turret at a considerable angle.

Accommodation and Ventilation.

The last—but by no means the least important—points to be considered in a comparison between the "broadside" and "turret" systems, are accommodation and ventilation. In making this comparison we should carefully bear in mind, that the health, comfort, and general efficiency, of those who are doomed to be caged up for an indefinite period (in so limited a space as even the roomiest ship, at best is) depends on ample accommodation: the production of a mere fighting machine, still further curtailed of space, will not serve our purpose. A ship is not only our battery—but our home!—our parade-ground, our hospital—in fact, our little world for the time being, from which there is no escape, no matter whether from the elements, the foe, or, that greatest of all foes, sickness; every inch of accommodation is, therefore, of vital importance, every inch curtailed, from that now often too limited space, is pregnant with danger and discomfort.

If the superiority claimed for the "turret" system on these two points, can by any possibility be demonstrated to the satisfaction of independent and unprejudiced minds, I say, with great deference to those who so strongly advocate the "broadside" system, that the "turret" has made out a very strong case; but I do consider that Captain Coles, and those who so warmly support his system, are bound to give some more satisfactory proof on this point than bare assertion. It may be deplorable obtuseness on my part, but I confess I am quite at a loss to understand how depriving a frigate of a large

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portion of two of her decks, as in the "Captain," and introducing "turrets" of 25 feet diameter on her lower or living deck, can produce an increase of accommodation; and looking at the wave-washed main-deck, and general arrangements, how the ventilation is improved—especially in hot weather—is equally puzzling. It must be remembered that the crew of a turret-ship are berthed on the lower deck, their only light being derived from scuttles cut in the armour-plates, whereas in the broadside they live in the spacious battery, well lighted and ventilated, having a clear lower deck to fall back upon if requisite.

Monitors.

Before quitting this portion of the subject, a few words on "sea-going Monitors" may not be out of place, especially as attempts have been made here, and elsewhere, to urge the adoption of these most unseaworthy fighting machines. That such vessels were most formidable, and very useful on the broad deep rivers of America, and that they did good service occasionally on the coast, cannot be questioned, neither is it untrue that there are some instances on record in which they behaved, for such vessels, well in bad weather; yet, as a rule, they made very bad weather, some were lost, and others nearly so.

It is also true that one came to Europe carefully convoyed by other vessels, and that another under similar circumstances went round Cape Horn. These two facts proved nothing more, in my estimation, and served no more useful purpose than did the voyage of Hudson in the wee ship "Red, White and Blue," or the winter race of the three American schooner yachts, all of which were undertaken in the same spirit of enterprize, and for the gratification of the same pardonable feeling of national vanity, further influenced perhaps in the case of the "Monitors" by political expediency. At all events, the experience and opinion of the warmest supporters of the turret system in this country is against them, they having been compelled to abandon the low deck and all-round fire, which is their strongest point, to try and make them seaworthy by adding a poop and forecastle, and deck accommodation. To contend that two such voyages proved the sea-going qualities of the class, and to urge the adoption of such vessels, for the *protection forsooth*, of the magnificent fleet of ironclad ships we now possess, is simply one mode of proclaiming utter ignorance of a subject which none but a practical seaman can properly grapple with.

I have taken some pains to elicit information respecting the performances of these vessels, but accounts and interests are so varied and conflicting, and opinions run so high, that it is impossible to form any save an adverse conclusion. One point, however, I believe, cannot be denied, and that is their great unpopularity in the American Navy, owing to their unhealthiness and general discomfort.

That some such improved type of vessel, but of a much smaller description, may be found eligible for our river and harbour defences, I will not for a moment question, but I have too much confidence in the abilities of our own naval architects and shipbuilders, to suppose for an

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instant that we shall require the assistance of Captain Ericson, or any other equally talented foreigner, to design them.

It appears remarkable that if the Americans are so highly impressed with the value of the turret system for sea-going vessels, they should not have applied it to the powerful corvettes they are now building, which are essentially the old type of broadside vessels; and I know on reliable authority that they are on the point of constructing ironclad ships on the combined broadside and end-on principle.

Steadiness of Platform.

Steadiness of platform after all is the grand desideratum; for guns and manœuvring power are comparatively useless, no matter whether in turrets or broadsides, unless a moderately steady platform can be obtained. Captain Coles of course considers that this is to be insured by the adoption of the "turret system," especially when accompanied with low freeboard; and he tells us that the difference between the rolling of his "turret-ship" and that of a "broadside" of the same class, would be as 7° to 20°—a difference which I very much question.

I believe it will be found that, even if a "turret ship" did roll to a less angle, she would roll much quicker, and therefore render firing even more difficult than with the slow roll of a "broadside ship." However, if there is a proper disposition of weights, and a fair proportion of length, breadth, and depth given, *which is quite as possible in one system as the other*, I see no reason why a turret-ship—the "Captain," for instance—should roll less or be easier than a broadside ship; this, however, will very shortly be proved. In the meanwhile I may observe that no one can for a moment dispute that the "Monitor" is the form least likely to roll of any description of vessel extant, being in point of fact the nearest approach to a raft, which has *no* oscillating motion. There is, however, a vast difference between the form of a "Monitor" and that of the "Captain," which is similar to an ordinary ship, and thus subject to the same dynamical laws; whereas the "Monitor" preserves the raft-like form aloft, in projections from either side, which constitute the main cause of her steadiness.

Although the form of the midship section has doubtless great influence on the steadiness of a ship, the longitudinal distribution of weight on a long flat floor is, I consider, even a more important element towards producing it. It is well known that ships and vessels of every class having the longest floor are invariably the easiest and steadiest. In the "combined end-on and broadside" system, all the weights are concentrated in the weight-carrying portion or "body" of the ship. The extremities being thus kept light, may be finer, which tends to an increase of speed, reduces pitching, improves steering properties, and contributes to the general steadiness of the platform. Now in the "Captain" this is reversed, the "turrets" being placed at each end, 152 feet apart; an unequal and wide-spread distribution of weight that will, I consider, have an injurious effect upon her performance as a sea-boat, and consequently as a gun-platform.

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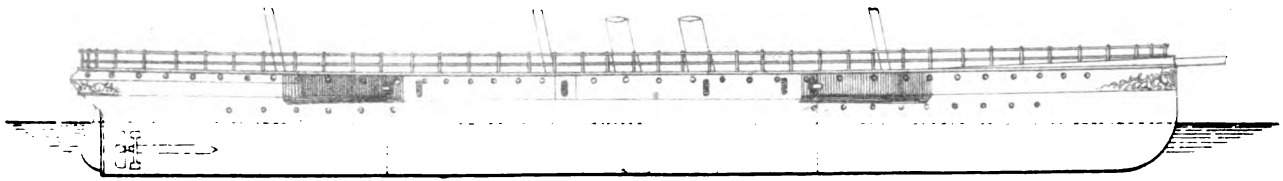
Elevation and Plan of Twin screw armed Transport "Bolivar"
with Capt^n T E Symonds R N Patent Indented sides.



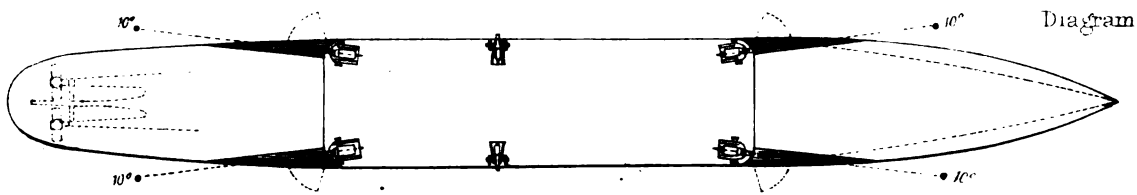
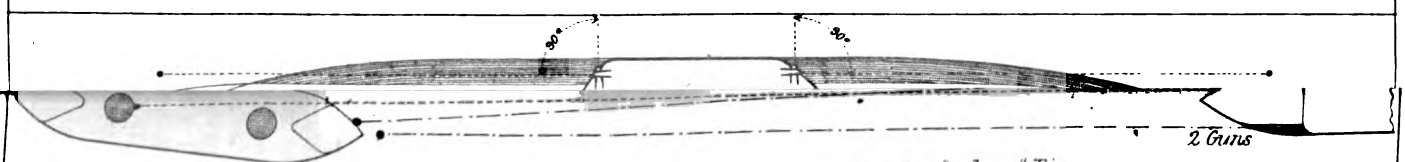


Diagram N° 2



Shewing the distinction between Symonds' & Coles' "end on" Fire.

J Jobbins

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In Captain Coles' criticism on the rolling of broadside ships, he appears to ignore upper-deck guns, which are already applied to some extent in existing ironclads, and are on the increase (*vide* Diagram No. 3, Plate xxxviii). These guns will give a great advantage over the turret in bad weather, or in fighting at close quarters, as they will bear upon the tops of the turrets and decks, they being 19, and in some of the latest models 20 feet above the load line. As stated in previous papers, I advocate having a lighter description of unprotected guns on the upper deck, believing that at close quarters they would much influence the fate of an action. A light spar deck to cover them and work the sails on, would be useful.

In the firm persuasion that the broadside type of ship was the best for sea-going purposes, but fully recognizing many weak points in the earlier examples, I have persistently endeavoured to make such alterations in the superstructure which, though calculated to reduce weights at the extremities, and give a better angle of training for the guns, would not interfere with the continuous side, on which there can be no question that a "sea-going ship," *in the genuine acceptation of the term*, must rely for support in a seaway. The first difficulty was the very uncertain power of manœuvring long ships with a single screw. The twin screw system, worked with separate and independent engines, not only relieved me of that difficulty, but gave me the power of absolutely pointing fixed guns with the greatest precision, the ship, as I stated in my paper of 1862, "*becoming the turn-table for her guns.*" However, the same disadvantages that I have dwelt upon in the turret-ship with a forecastle and poop, occurred to me in this twin screw-ship, which led me to the invention of the "indented side," a plan to which I have referred on several occasions in the course of this paper, the value and originality of which was so courteously acknowledged by the Controller of the Navy, in his able speech during the discussion on Captain Coles' last paper at this Institution.

The next weak point which presented itself to me was, I frankly confess, that on which Captain Coles justly dilates, although perhaps rather caricaturing the picture; I refer to the small arc of training attained in the broadside port (even when every sacrifice is made to increase it), and the difficulties attending loading broadside guns when rolling in a seaway. It is with a view of remedying these certainly weak points in the broadside system, that I have invented the construction of a port, represented in the diagrams before you; in the discussion of which point I trust to receive that assistance which can alone be found in the criticism of able practical men, and such as has invariably assisted me at this Institution. Diagram No. 6 (Plate xxxix), represents three views of a broadside port retired, or recessed, two feet from the side, A the plan, shows that an arc of 90° training is obtained by this method, with a 300-pounder gun in a port 2 *feet* 4 *inches wide, which is* 5 *inches less than the ordinary port*, in which an arc of only 60° is obtained by bevelling to such an extent as to weaken the structure in the wake of the port; the gain in my method is therefore 30° additional training, decreased width of port, and greater structural strength; 18 inches recess would give a similar result in training. B

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is the elevation shewing the method of closing the embrasure, so as to present a smooth side to the water when not fighting; the upper half is shown open in the diagram. C is a section of the same with gun run out, port 3 feet 10 inches high, elevation 10°, depression 7°. The carriage shown in the diagram is intended for that of Captain Scott's, but were a slide fitted with a pivot-bolt it would be under the incline of the recess, and almost immediately under the muzzle; it would be thus well protected, and in a better position for training; the triangular space "*a*" shown, represents one face of the embrasure, the side of the ship being tumbled home. I curve the top-side outwards, which is calculated to throw off a very considerable mass of water, that might otherwise break in-board in ships that do not rise to a wave. The advantage of fitting ports on this system will, I think, be evident on referring to Diagram No. 1, in which the lines shown represent the command by the new system, the dotted line the command of the foremost gun in the old. Thus in a ship with 18 protected guns, it will be seen that at 80 yards there are eight guns on the new system that would bear, but none on the old, and so on; with four protected guns to fire on a line ahead or astern through an arc of 90°, and one unprotected chase gun at either end. The broadside concentrating at 13 yards by the new system, and 24 yards by the old, I thus show an uninterrupted all-round fire, free of all those contingencies consequent on firing over the "Captain's" deck; no point is undefended, the normal construction of the ship remains unchanged, save in the upper works; and those changes do not involve any great alteration of form or difficulty of construction.

In this early stage of the invention I may have overlooked other objections or advantages: leaving you to kindly furnish the former, I will briefly allude to several of the latter. It is equivalent to an increase of freeboard of rather less than one-half the distance recessed. Thus, with the port recessed 5 feet, as in Diagram No. 7, Plate xxxix, it could be kept open as long, or longer, than an ordinary port in a ship with two feet more freeboard, as represented by the dotted lines, both ships being shown at the same inclination. Diagram No. 8, Plate xl, illustrates two ships of the *same freeboard*, one with the ordinary port, the other with the port recessed 4 feet, ship rolling 20°, showing that the recessed port can be kept open and the guns fought, when it would be impossible to open the ordinary port. *With the lower part of the recess closed, as shown in this diagram, it might be kept open still longer.* With the embrasure thus partially closed, the gun may be sponged, loaded, run out, and *pointed*, the object being kept in view through the sighting aperture over the port, the gun's crew being protected from riflemen, grape shot, &c. In extreme training there will be more room for working the gun, and the men will be less exposed. The muzzles of the guns do not project beyond the side, and are, therefore, protected from raking fire. A ship so fitted could effectually mask her battery. Lastly, this is a means of relieving the side of the ship from undue weight; is favourable to tumbling home the topsides even to a greater extent than shown in the diagrams; and for all practical purposes the armament is sufficiently centralized. Unless

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some insuperable objection turns up that neither I, nor those I have consulted, have hitherto discovered, it appears to me that this system will add materially to the efficiency of the broadside-ship, and disposes of many objections raised by Captain Coles, as regards exposure of the gun's crew when loading, either to "green seas" coming in through the ports, or to the "fire of small arms picking off the men;" bearing in mind that a port on this system is very little, if at all larger than the turret ports, which are *two to one*, and that muzzle pivotting can be as readily applied in one case as the other.

In conclusion, I venture to hope that notwithstanding the shortcomings of this paper, which, considering the importance of the subject under notice, claimed more time and care than severe indisposition enabled me to bestow upon it, it may, at least, have the effect of leading discussion into some channels that have not hitherto been opened up; I hope also that I have succeeded in demonstrating that the broadside type of ship, is that best calculated for maintaining our prestige on the ocean, and is *not so deplorably deficient of every attribute that a fighting-ship should possess, as to necessitate appeals to Parliament—or any other sensational manœuvre, or agitation, for a reconstruction of our sea-going Navy on the turret principle.* I believe such a measure to be fraught with great peril, and I am convinced that a wise discretion has been shown in resisting the pressure in that direction, till some more satisfactory evidence has been received of the actual performance of a turret-ship, beyond the accounts of smaller vessels on that principle, which, as a rule are anything but satisfactory.

Mr. Bell Galloway: My Lord and Gentlemen,—As this subject, the subject of ships of war, has occupied my special attention for twelve years, probably I may for a few minutes interest you. I have lived long enough to learn this one lesson, that it is not always wise to ignore the wisdom and experience of our ancestors. I am not one of those who advocate a reconstruction of Her Majesty's Royal Navy, and I believe that we are approaching the time when it will be found to our cost that the wooden ships that have been so much condemned, after all, possess properties and qualities which iron ships to a very great extent will be found deficient in. In reference to the paper which has now been read, I agree very much with what Captain Symonds has said in respect to that part which he quoted of his paper which he read in 1863,—altogether in that part in which he advocates the necessity and value of light armour on the upper and other parts of the vessel. But I have just this one suggestion to offer. I have a plan—we all think our own plans the best—I should feel honoured and extremely glad, and I ask the privilege as an Englishman, upon national grounds, for this Society to give me the opportunity to produce my combined plan of the broadside and turret principles. I will put that plan side by side with Captain Symonds' and Captain Coles', and leave you, Gentlemen, to form your own opinion.

[The Chair was here taken by Rear-Admiral Sir F. W. E. Nicolson, Bart., C.B.]

Commander Colomb, R.N.: Captain Symonds opens up to us questions of the greatest possible extent, and it is most difficult to say how far their bearings upon the question before us apply. He mentioned the reasons which led him to place the guns at the extremities of the ship, to get the fore and aft fire, but he did not mention, what I think is the most important reason of all for the end-on fire, and that is, the use of the weapon which proved so destructive at Lissa. Now I am not going to get upon my hobby, members need not therefore be afraid. I am not going to wander from the discussion, but I think, whatever we else saw at Lissa, we

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saw enough to assure us, that ships can no longer, with security, keep themselves in the best position for fighting guns placed on the broadside, without reference to end-on fire. I look upon it that we are getting more and more into the position that we were in, when guns were first introduced, viz., that ships will get more into the way of fighting their battles nearly end-on; because if one ship is intending to attack with her ram, the ship which intends to defend with her guns cannot do so to the best advantage to herself, unless she is able at the same time to take a position something like end-on to the ship which is going to attack her with her stem. Therefore, I think on that ground, without reference to any other question, I should support the plan which gives us the best end-on fire, because I think that a fire which can only be used on the broadside, is becoming every day more and more useless. I could almost have wished that this discussion had been adjourned to the marine shed of the Exhibition of Paris, where there was every description of possible, and, I might almost add, impossible, ship before us, and where we should have seen attempts to give this end-on fire in the best possible manner, and the broadside fire as well. Now, as regards a competition between the two principles which have been so prominently brought before us to-night, the turret principle and the broadside principle, I own that I have always had, and that I still have, the greatest possible difficulty in coming to any conclusion upon the subject, and my endeavour has always been, and I am afraid even after what we have heard to-night, my endeavour must still be, to keep my mind open. We were told, first of all, that the turret system enabled a ship to be completely armoured, that there was no part of her, not completely armoured, exposed, and that it was not possible fully to armour a broadside ship. Then, after a little while, that point disappeared, and it was proposed to build partially armoured turret-ships. Then it was said that the turret was a necessity for using the heaviest classes of guns; that these heaviest classes of guns which had become a necessity from the increased defensive powers of ships, could not be worked except upon the turret principle. Well, that appears to have been put to experiment, and, so far as I can gather, those who are most acquainted with the subject say that this has disappeared as a fact altogether, that there is no difficulty in working the heaviest guns upon the broadside. At the same time I cannot help recollecting, that when there seemed a chance of our going to war with Prussia and Austria in reference to Denmark, I looked upon that "Royal Sovereign" (I had heard remarks all round me that that was the ship to send), and that she was the most effective ship in the Navy, and my instinct told me she was the most effective ship in the Navy, but why, I am unable to say. Many remarks have been made to-night about the height of freeboard, and I have been surprised to hear people from time to time saying that such a vessel has so much more freeboard than another ship, and is able to fight her guns so much longer. Now, the working of guns depends upon other considerations than the height of freeboard. A small ship with small freeboard will be able to fight a gun on that deck (pointing) when a large ship with very much greater freeboard will not be able to do so. As regards the point brought forward, that of advocating many light guns—

Captain SYMONDS: Not light; I did not say "light." Smaller—taking the 300-pounder, for example, instead of the 600-pounder.

Commander COLOMB: There can be no question, I think, that if you can get guns to penetrate, the smaller those guns are, and the more of them you have, the better. Again, we have the twin screws. I am sorry to enter into so many particulars, but this point arose. Captain Symonds is a very strong advocate for the twin-screw system; perhaps I am also, to a certain extent. I fully agree with his remarks about the great facilities given by the twin-screw for turning, where questions of space alone are concerned. He gave us an extract from a letter showing how admirable the twin-screw was in going to an anchorage amongst fixed points. Now, the twin-screw has great manœuvring advantages, when you are dealing with space alone, but it has no advantages where you are dealing with questions of time, and it does not give you advantages as a rule in fleet movements. I am very much surprised at the plan which has been submitted to us, of the upper deck of the "Captain." I hoped to have seen in the Exhibition at Paris a model of the "Captain;" her name and the place for the model is there, but the model itself is not there. I must say that

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I am very much surprised that the best turret-ship, the turret-ship the plans for which, were left in the hands of the inventor entirely, should be in the position of having no "end-on" fire, either at the head or stern within six degrees each side of the line of the keel. It seems to me—what shall I say? a most tremendous oversight. If it is a necessity of the turret system; it is so much to the discredit of that system. As to the explosion of shells in turrets and in "the box," to give it the name by which it is generally called, I think Captain Symonds forgot to point out to us that the chances of the shell bursting in "the box" were very much greater than the chance of a shell bursting in the turret, because "the box" is a very much larger object. The destructive powers of the shell would perhaps be equal, but I think as a matter of fact, the chances of a shell bursting in a turret are very much less than the chances of a shell bursting in the larger object—"the box."

Captain SYMONDS: The point in Captain Coles' paper was the entry of the shell through the port, because the port was so large. He contended that the ports were so large that the shells must necessarily go into the large "box."

Captain COLOMB: I was very unfortunate in being obliged to be away when Captain Coles read his paper, but I do not think that matters, you have so many more ports. I will only make one other remark about the disposition of the weight. Admiral Paris shewed me some experiments of his with reference to the question of the disposition of weights as affecting the rolling properties of ships. He had made an instrument for registering very accurately the extent to which ships roll. I was very much struck with one of his experiments. In one case he made the experiment with a boat. He placed the weights in the centre, on the line of the keel in the first instance, and afterwards at the side, as the armour-plates would be. The rolling was very much less in degree when the weights were placed at the extremities than when they were placed in the centre.

Captain SYMONDS: The extremities of the ship?

Captain COLOMB: No, the extremities of the beam. The weights were the same height from the water.

Captain F. B. CRAUFURD, R.N.: Captain Symonds referred in his paper to the American "Monitors." Now I happen to have seen the one that went round Cape Horn. I went over her, and heard of her performance at sea, and she certainly appeared to me to be an instance of seaworthiness which told very much in favour of the style of ship she is. She was accompanied by the "Vanderbilt" and the "Tuscarora," and was with them when they were caught in a very heavy gale. The "Monitor" fell into the trough of the sea, and the "Tuscarora," which lay to at the same time, thinking that something would happen, that the "Monitor" would be submerged, bore up to her assistance. The sea was so heavy that it broke on board the "Tuscarora," and forced its way down her hatchways, putting the fires out. She was nearly swamped, but, strange to say, the storm had not the slightest effect upon the "Monitor." She was flat-bottomed, and had one very small mast. She could fire in every direction all over the deck. As I said, I went over her, and her accommodation below was very good. Her ventilation was said to be perfect. Her speed was said to be nine knots. She carried 14 days' coals, and has gone from the United States through the Straits of Magellan to San Francisco. Like Captain Colomb, I think it is very difficult to decide upon the merits either of the turret or the broadside principle. One thing I am very glad of, and that is that a ship on the former principle is being built, and that the inventor will have a fair opportunity of testing his principle thoroughly, and we shall then on our parts be able to come to some decision.

Captain SYMONDS: Had that "Monitor" two screws?

Captain CRAUFURD: She had two screws.

Captain SELWYN, R.N.: I must first pay what I think every member will think very well deserved, a tribute of admiration for the way in which the paper has been prepared under the difficulties Captain Symonds has gone through, and for the very able way in which he has put his subject before us. Secondly, I should like to draw attention to the fact that in all these matters, not less in guns than in ships, we are engaged in a series of compromises; that whereas the works of the Creator come from His hand perfect for every purpose for which they are designed—for instance,

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the wild swan is as perfect in the air as in the water—man must necessarily always engage in compromises, and he acts very unwisely when he seeks to exclude compromise. When he tries to get long range, as well as great penetrative power in shot, or sea-going qualities in connection with invulnerability in ships, he must necessarily exclude some other most important points. Complete invulnerability, which was the point at which Captain Coles aimed in his turrets, was obliged to be supplemented, because the ship that carried the turret would go down if she too were not armoured; while you will recollect every bit of armour on these broadside ships is as well devoted to the defence of the gun as to the defence of the ship. It fulfils therefore two objects, instead of fulfilling, as in the turret-ships, only one. Now with regard to the "tumble home," it is, in those parts of Captain Symonds' ships devoted to ports, a tumble home to all intents and purposes. Mr. Galloway, who has spoken, admiring the wisdom of our ancestors, carries me very much with him. I remember in all large ships what some call the rule of thumb—I should say the science of our ancestors—taught them to bring their weights inboard and make the upper decks tumble home. They obtained many of the advantages in their large ships which Captain Symonds has obtained here. A point which has not been adverted to to-night, but which is a most important one, is that of the power to engage on both sides. Recollect that the comparison of the weight of metal of the cupola ships with that of the broadside ships, has always been made as if it was supposed we should never again engage on both sides. That is a very unfair comparison. When we see sixteen guns in the broadside ship, and four, or possibly six, in the turret-ship, we must remember that not even the difference of 600-pounder guns as against 300-pounders, which I do not admit to be a necessity in any way, for I have always said broadside ships can carry any weight of guns you choose to put in them—it is entirely an affair for the naval constructors—if even that were the case, and our broadside ship cannot carry the same weight of guns, yet the difference of the number of guns and the power of firing on both sides, leaving out the question of "end on," would be much too important for any maritime nation to overlook. It has been remarked by Captain Craufurd that he had heard the testimony of her officers as to the behaviour of one of the "Monitors" at sea. But I want to know, supposing we have a fleet in which we have got a certain number of "Monitors," which can go nine knots, and a certain number of broadside frigates, which can go fourteen, are the broadside frigates to keep down their speed of fourteen knots in order to keep with the "Monitors" of nine knots? Are they, when there is a fair wind, to wait when they could go 12, 13, perhaps 14 knots, under sail; are they to wait because the "Monitors" cannot steam more than nine? what would be the result of such a mixed and heterogeneous fleet? But of course that is on the assumption that "Monitors" can be made sea-going; for though "Monitors" have made passages, I utterly and totally deny that anything that does not hoist an amount of canvas proportionate to her size can ever be considered as a proper sea-going ship. I regret very much—I do not know whether it is from the necessities of the case or the ignoring of the naval officers' wishes—that we are now deprived of masts in ships of war, and have only jury-masts in their stead, so that we are under the lamentable necessity of getting up steam if we have to wear or tack. We cannot move, in fact, without reference to our engineers, and our engineers tell us that to drive this enormous ship at any speed such as you think proper for her, you must have such a horse power concealed under the nominal horse power as would infer a consumption of fuel which leaves you for your finest ships only four days' coal to go to sea. Here is the "Bellerophon" at this moment only carrying four days' coal. [A MEMBER: Full power?] I assume that you want to chase, or do anything that may be required. The fact is, you have descended from ten days' coal to four. That is not wise; it is not worthy of our age, and something must be done to economise fuel in some way, in order to restore us to our ancient power of going for longer voyages than four days under full steam. But why should we ignore the wind? Mr. Cunningham has very cleverly carried us on in machinery for our sails, so as to give us even with reduced crews a power of managing sails which are in full proportion to the ship. That ship, if full rigged (pointing to one of the diagrams), we have every reason to believe, will give us a proportionate speed

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as far in excess of what has been attained by former ships, as the liners of to-day to Australia are in excess of the old vessels, which used to be content to go seven knots on a bowline, and twelve when they got before the wind. I must say also, though in Captain Symonds' presence, that to his illustrious uncle we owe, in his day, the very greatest improvements in the Navy, and that he is following worthily in his uncle's steps. There is another point I should wish to draw your attention to, namely, that the latest improvement in finding out the causes of the rolling of ships, described by Captain Colomb as the work of Admiral Paris, might be seen in Somerset House in a tank as the result of the studies of Sir William Symonds. He devised models; he carefully calculated the effects of the disposition of weights, and shewed how the times and depths of rolling might be increased or decreased at pleasure; and he taught us the mathematical laws by which the rolling of a ship may be brought under proper control. All these things make me extremely reluctant to fly at once to a system—the turret system—which I have always said, and shall continue to say, is most admirable for the purpose for which it was designed—for coast defence and for shallow water attack—but which is utterly unfit for many of those objects which the fleet of England ought to be able to fulfil at sea.

Mr. BELL GALLOWAY: Might I be allowed to add this one remark? Following up the remark that the "Bellerophon" can only carry four days' coal, I offer to save 15 to 25 per cent. in every ship in Her Majesty's service, and I will prove that I can do so if I may take a ship to prove my experiments by.

Captain FREMANTLE, R.N.: I wish to ask a question with reference to that diagram of Captain Symonds, before us. There is a gun to fire right ahead, by the end-on system, and he tells us, I believe in the "Bolivar," the vessel which he quoted, and another ship, that their guns fired only nearly, not quite, in a line with the keel. I believe I am right in saying, that no vessel has been built with a gun to fire right ahead. If I am wrong, Captain Symonds will tell me so, but this gun seems to me to be firing right ahead.

Captain SYMONDS: Which is the gun you refer to?

Captain FREMANTLE: I am alluding to this gun (pointing), supposed to fire right ahead or astern. The great argument against the turret-ship being that she would only fire within six degrees of the line of the keel (I think it is important), it would seem to me that when the ship is heeling considerably, say 15 degrees, it would be rather a dangerous thing to attempt to fire that gun, or to attempt to fire a gun in that direction.

Admiral ROBINSON: I think the Officer who has just spoken has misunderstood Captain Symonds altogether. The gun on the upper deck does not interfere with the gun on the main deck, or below it in any way whatever. If I am not mistaken, Captain Symonds, that is your position? The gun that fires fore and aft is on another deck; it is not on the same deck.

Captain FREMANTLE: I understood Captain Symonds to say that the gun I have alluded to is supposed to be on the main deck. I would also ask Captain Symonds whether, when the ship is heeling 15 degrees, he is of opinion that it would be safe to train the gun in the line of the keel? whether it ever has been tried?

Captain SYMONDS: To answer the questions that have been put to me; and firstly, with reference to Captain Colomb's remarks as to freeboard, I am not aware that I took any position with regard to freeboard. I merely touched upon freeboard in mentioning that Captain Coles expected to get a more steady platform by simply reducing the freeboard. That I do not agree with at all, because there are other conditions to be considered as well as the reduction of freeboard. As to twin screw ships, it is not my purpose to lecture on twin screws now, but simply to reply to Captain Colomb by saying this—that I do not know any position, whether in narrow or in broad water, where a twin-screw ship cannot turn quicker than any other. At all events, if there is any other, I have never heard of her. It is quite against my experience. I see a gentleman here who has built some twelve or fourteen twin-screw ships, and who perhaps can tell me if he has ever heard of any that can turn quicker. As applied to ships of war, I look upon the value of twin screws for the purpose of turning your ship *half round*. You never want, as Admiral Hulsted jocularly expressed it, "to spin a cockchafer" with a ship,

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turning her round and round, but you simply want to turn her *half round*, or you want to do that which you can do with the greatest facility—move her through an arc of 20°, 30°, or 40° backwards and forwards with the same precision as you can a turn-table.

Captain COLOMB: My remark was, that with regard to the question of *time*, when you wanted to turn quicker, the twin screw gave you no advantage.

Captain SYMONDS: I am quite aware that short ships with long heels and large screws, and proportioned to effect quick turning, have described a circle more speedily than long, narrow ships, with twin screws. But making all conditions the same, you will find, I believe, that the twin screws will turn a ship as quick, or quicker, than any other means. The great saving, however, is that of space. A twin screw ship will turn in her own length with a degree of certainty *both ways*, a property which no other ship possesses. I do not think that the great advantage for war purposes is that of turning the whole way round, but of *half* turning. As to the rolling and weights, I am very glad to hear so high an authority as Admiral Paris on that point. It is a point, as Captain Selwyn said, which has been determined by experiments with models and in other ways many years back. I have always believed that weights on the broadside would, supposing the bottom to be in the proper form, reduce the rolling; at all events, as I said in my paper, make it easier, and therefore better, for fighting guns than would be the case with central weights. I have observed in every case of the central weight, whether in the keel or the deck of a small vessel more particularly, that there was a quick motion, a roll to windward very often under canvas—there was a constant quick jerking roll that would destroy any aim. This was not the case when the ballast or weights were properly distributed. With reference to Captain Craufurd's remarks on the "Monitor," I do not for an instant contend that that class of ships could not cross the seas, but they are not sea-going ships. I mentioned that we had had two instances of their doing so. It is no doubt satisfactory to hear that they have done it so well as his informants mention; but it is very extraordinary to find that officers who have been in the same "Monitor" give such very different accounts of her performances. That is a difficulty referred to in my paper. There is no reliance to be placed on the accounts you hear. One man says they are admirable sea boats; another, that they are always under water; a third says that he can hardly breathe between decks, and that the engines which do the work of ventilation sometimes break down, and the men are very nearly stifled. Another man tells you he has much purer air than on deck, and thinks it is a most agreeable thing to be in a constant draught. It is a sort of thing I cannot quite understand, but at the same time I am much obliged to Captain Craufurd for making those remarks.

Captain CRAUFURD: I examined the ship, and the statements appeared to be borne out.

Captain SYMONDS: I apprehend that I am not wrong in understanding that you *heard* these statements, but that you had no experience on board her.

Captain CRAUFURD: No; I had not.

Captain SYMONDS: With respect to Captain Fremantle's remarks, I may state that I read a list of ships, embracing most of the principal iron-clads in the Navy, all of which had fore and aft guns, many of them on that principle, but those guns were on the upper deck only, and were much further forward than in this diagram. This ship represents a smaller class of ship than the "Northumberland" or "Minotaur." The "Minotaur" has guns as far forward as this (pointing), with the same sort of indent, only far shorter.

Captain FREMANTLE: Firing on the line of the keel?

Captain SYMONDS: Yes, I speak under correction, but I believe, in fact, that their fire will absolutely converge. I have never heard of it, nor do I believe that there is the slightest difficulty in firing the guns when the vessel is heeling, any more than when she is upright. We must remember this—that we are not in the same position with regard to guns and carriages *now*, that we were ten years ago. It is one thing seeing an old 68-pounder slip about a ship's deck, like an egg rolling on a table, and another to see one of those magnificent gun carriages now in use, that can be worked in the most admirable manner quite as easily as you can move a locomo-

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tive on a turn-table. If 600-pounders are introduced into the broadside system, we shall find that they may be controlled in the most perfect manner. Therefore, I consider that you have no need to be under any apprehension as to the working of the gun in training at a moderate inclination or rolling. I would go as far as 15 or 20 degrees. I think I have answered your question on that point, and also on the practicability of having this indent on the main deck, as well as the upper deck. We have no ship in the service where it is upon both decks, but we have one where it is upon the main deck, which is the most difficult point.

Captain FREMANTLE: Can the guns of the "Pallas" fire along the line of the keel?

Captain SYMONDS: At 14 degrees. I stated she was a converted wooden ship, and therefore it was not possible, under those circumstances, to give her the right-ahead fire without pulling her to pieces. In this ship (Fig. 3), which is a ship to be built for Her Majesty's Government, there is the line ahead fire on the upper deck, with a long indent, very much longer than we see here. Again, the possibility of fighting these guns on the main deck was shown in the "Bolivar," as I have mentioned. She had 70-pounders only seven feet six from the water. It was very heavy weather, and I am assured by her captain and officers that she never shipped a drop of water, that the guns were cast loose, and fired with the greatest possible ease; and I think you must remember that one great argument for the turret system was that the gun could be fired fore and aft when the ship was rolling, which could not be done on the broadside.

Captain FREMANTLE: If the gun were amidships you would not feel the roll so much.

Captain SYMONDS: I do not see the difference at all. The point was this. Some gentlemen who are supporting the turret principle contended that they could turn the gun fore and aft, and load with much more ease than on the broadside. Now, these guns are in precisely the same position. I am extremely obliged to you, gentlemen, for bringing forward for discussion any points in this paper, and I have to thank you very much for having listened so patiently to a very long lecture. I only wish you had been rather more severe in your criticisms, but I hope on a future occasion, when I am better able, to give you something more to the purpose than I have done now.

Sir FREDERICK NICOLSON: Before the meeting breaks up there is one duty we have to perform, which, I presume, you will all agree with me in, and that is to thank the lecturer for the paper which he has placed before us. It is a matter of great regret that Captain Coles is not here. He is not only an ingenious inventor, but also an able advocate, and so readily meets all the points brought against his system, that it is a matter of great regret he is not here to-night. But I am happy to be able to announce that he has applied to the Council for another day. I do not know what the title of his paper is to be, but if I remember rightly, it was said in his letter to be "What a turret ship ought to be;" so that if he is able to prepare that paper, I think there will be an excellent opportunity for again discussing whether it is possible to make a real sea-going turret-ship; for after all, these "Monitors" we have heard of, are not, in the fullest acceptation of the term, real sea-going cruizing ships.

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LECTURE.

Friday, May 17th, 1867.

MAJOR-GENERAL SIR FREDERICK ABBOTT, Kt., C.B., Member of the Council of Education, in the Chair.

MILITARY LAW.

By Captain G. FREDERIC BLAKE, Royal Marines, and Student of the Middle Temple.

BY the kind permission of the Council of this Institution I am allowed to address you on the subject of military law. It is a subject to which of late I have had to pay close attention, and for which I have had special opportunities. I have ventured to hope that, from such incidental advantages, I might be able to collect and bring before you some observations relevant to military law which might not be altogether uninteresting to those who honour me to-day with their presence and attention. The more I have considered the subject, the more I have seen its importance and extent, and consequently the more I have felt my own incapacity to do it justice. I do not attempt, therefore, to offer you anything in the shape of a regular essay on military law; much less do I presume to advance crude opinions of my own as to its merits or demerits. I will strive to get through my task with as few legal and military technicalities as possible, and not weary you with the abstruse, recondite learning of others, or tiresome avowals of, and apologies for, my own inability and inexperience. What I have to ask you to listen to is, first, a faint outline of some of the usages and penalties of a martial kind in former days among the two great nations of antiquity from whom our laws as well as our literature take their richest source; then briefly to glance at those particulars as they appear in the earlier days of English history, and afterwards to come down to our own times, casting a side glance at military legislation as now existing among our continental neighbours and our transatlantic cousins.

Before touching on our military law, I would just glance at the practices and rules laid down in former times by other great nations

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for maintaining discipline among their forces. It would be very interesting to follow the course of law as applied to soldiers distinct from that as applied to citizens through all countries and peoples from the earliest times, but of course that cannot be done on this occasion. I will merely ask you to turn with me to the two great nations of antiquity, the Greeks and the Romans, who each in their turn swayed the sceptre of power in the civilized world.

Greeks.—During the first ages of Greece, the unsettled state of society led to a general acquiring of the art of arms for the purpose of predatory inroad or self-defence. Perhaps the earliest notices of the Greek armies are in the Homeric poems. In the heroic ages, authority and obedience were regulated more by the nature of the circumstances, by the relative personal distinction of the chieftain, than by any set law of military discipline. With the Spartans, every free man became a soldier. When all of a family were not wanted for an expedition, those who were, seemed to have been chosen by lot. After the heroic age, a great impulse was given to military art by the conquests of the Thessalians and Dorians; the latter, in particular, reduced it to a system. The code of Lycurgus was a complete military one, and the discipline was of the strictest kind. The Athenians were less exact than the Spartans. They had ten officers called Strategi, one of whom went with an army, and presided at a species of court-martial, which consisted of members who had served with the offender. The military law of Athens prescribed the punishment of death for the crime of desertion while on service, though occasionally a fine or imprisonment was inflicted instead. An Athenian soldier considering himself unjustly treated, at the end of the campaign could compel his Officer to answer for his conduct before a tribunal of his countrymen. Agamemnon, in the Iliad, threatens with death those who may desert. Alexander the Great executed without a trial, thirteen Macedonians who had mutinied. Among the Lacedæmonians, cowards or deserters were either put to death or publicly disgraced. Military offenders, when at home, were made to wear a party-coloured dress, and were compelled to submit to any insult the meanest citizen chose to offer. Disgrace fell upon a soldier if he lost his shield in action.

Romans.—In the early ages of the kingdom and the commonwealth, every citizen became a soldier, and was at all times liable to serve. There were frequent calls for service. Protracted service became inevitable during the Carthaginian invasion, and when the dominion of Rome extended over Greece and Asia; but to the end of the Republic, the principle was recognised, that when a campaign was concluded, the soldier might return home and resume the occupations of a peaceful citizen. The practice introduced on a large scale of granting donations of land as pensions for long service, led to the creation of a numerous class disposed to devote themselves permanently to a military life. Augustus, with the advice of Mecænas, established a powerful standing army, each soldier of which took an oath to obey orders. The Romans punished military offences with extreme severity, soldiers guilty of the gravest offences being beheaded or crucified. Under the Pagan Emperors, some were burnt alive, or exposed to wild beasts. On the

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occasion of a mutiny, every tenth man, chosen by lot, was punished. Deserters, after being scourged, were frequently sold for slaves. Occasionally the offender was made to bare his right arm, and was bled nearly to death. Centurions sat as judges of various military offences, and had the power of inflicting corporal punishment, whence their badge of office was a vine sapling (Smith's *Antiquities*).

Coming to our own country, allow me to read a short extract from Hallam's *Middle Ages* bearing on my subject:—

"In public national history I am aware of no instance of what may "be called a regular army more ancient than the body guards, or "huscarles, of Canute the Great. These select troops amounted to "6,000 men, on whom he probably relied to assure the subjection of "England. A code of Martial Law compiled for their regulation is "extant in substance; and they are reputed to have displayed a mili- "tary spirit of mutual union, of which their master stood in awe.

"NOTE.—*Singular Story.*—Canute having killed one of their body in "a fit of anger, it was debated whether the King should incur the "legal penalty of death, and this was only compromised by his kneel- "ing on a cushion before the assembly, and awaiting their permission "to rise."

It appears that among the Anglo-Saxons every freeman bore arms, and was trained to their use. I have not been able to discover any laws bearing upon their condition as soldiers, apart from that of citizens. At the Conquest the feudal system, which was altogether a military one, was fully established. It gave the Sovereign most despotic power over his vassals, and he had power to compel their military attendance and service, under the penalty for disobedience of a forfeiture of their lands. Even after the passing of Magna Charta, we find that every possessor of a knight's fief (and there were some 60,000 of them) had to furnish a soldier to attend the King in his wars for 40 days in every year, and to pay their expenses. Though the feudal system was not abolished till the Restoration, we find that paid bodies of troops were raised for special services. The early Kings employed them in their invasions of Scotland and in their French wars. Grose's book of *Military Antiquities* contains a collection of ordinances relating to the discipline of the English forces. I will not weary you by reading many of them, but merely quote a very curious one, showing the severity of the punishment resorted to in early days:—

— Charter of Richard 1st, 1189 (Rymer). "Richard by the grace "of God King of England, Duke of Normandy, &c. To all his men "going by sea to Jerusalem, greeting,—Know ye that by the common "council of all good men, we have made the underwritten ordonnance: "—He who kills a man on shipboard shall be bound to the dead man "and thrown into the sea; if the man is killed on shore, the slayer "shall be bound to the dead body, and buried with it. Any one con- "victed by lawful witness of having drawn his knife to strike another, "or shall have drawn blood of him, to lose his hand. If he shall have "only struck with the palm of the hand, without drawing blood, he "shall be thrice ducked in the sea. Anyone who shall reproach a "man, or curse his companion, shall, for every time he is convicted

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"thereof, give him so many ounces of silver. Any one convicted of "theft shall be shorn like a champion;* boiling pitch shall be poured "on his head, and down or feathers shaken over it, that he may be "known; and he shall be set on shore at the first land at which the "ship touches.

"Witness myself at Chinon."

From Grose, too, we gather that in the early period of our history the administration of military justice was chiefly directed by two important officials, the High Constable and the Marshal. They presided at tribunals formed of both civilians and officers, and not only tried and punished military offences, but also settled all kinds of suits between the followers of an army. In these early days we find military delinquents sometimes tried before Parliament. Henry de Essex, standard bearer to Henry II., was, for cowardice, deprived of his lands, and shorn and shut up for life as a monk, in the Abbey of Reading. In the first Parliament of Richard II., William de Weston and the Lord of Gomery were tried for delivering up the Castle of Arden, and sentenced, the former to be drawn and hanged, the latter to be beheaded.

The martial law for the time being, was declared in the Rules and Ordonnances of War, which were either made by the King, with the advice of his peers, for the expedition then on foot, as was that of Richard I., which I have read to you, and that of Henry V., or enacted by the Commander-in-Chief, who had authority given him by Commission from the King. Shakspeare puts expressions into Henry V's mouth, which show how strict was the discipline in his army. Fluellin has told the King that one Bardolph is like to be hanged for robbing a church. The King replies, "We would have all "such offenders so cut off; and we give express charge in our marches "through the country, there be nothing compelled from the villages, "nothing taken but paid for; none of the French upbraided, or abused "in disdainful language, for when lenity and cruelty play for a kingdom, "the gentler gamester is the soonest winner." Rymer mentions many commissions for executing military law even so recently as the time of James I. That King appointed Sir H. Vere, Captain General of the Army intended to be sent to the Palatinate, and in his Commission he is authorized to make and proclaim ordonnances of war for the government of the Army, and to enforce the execution thereof, and to hear, determine, and punish by himself or deputies, all criminal causes, mutinies, and desertions, and all other crimes whatsoever, and to punish by death, loss of member, or other corporal infliction, according to their crimes, and the laws and customs of war; and also to hear and determine in like manner all civil causes, contracts, &c., arising in the said army. Also in like manner to judge all persons that may in future join the Army. A similar commission was granted by Charles I. to the Earl of Arundel, to be Captain-General of the Army employed at home, in which he was authorised to appoint a Provost-Marshal to execute the martial law. In the reign of Henry VIII., the office of

* Champions, hired to fight legal duels in cases of murder or homicide, had their hair shorn.

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High Constable ceased, and the High Marshal afterwards executed his military judicial functions. In the ordonnance of this reign we find—"Item,—the High Marshal must hold two Court days in the week, "that is to wit, on Monday and Thursday, for them that have any "matters in Court, with his officers with him, as it is ordained by the "Chief Captain." Gradually the powers executed under the commission granted to the Commanders-in-Chief, lessened the independence of the Marshal's Court, and soon we have courts or councils of war, which sat at stated times, or as ordered by the Commander-in-Chief, and at which officers of a certain rank (apparently not under that of a Colonel) were entitled to sit as assessors or members; and instead of a Marshal, we hear of an officer styled President of the High Court of War, who on certain occasions claimed the privilege of a double vote. Sir Francis Vere, in his description of the duties of the several officers of a regiment, mentions it as the duty of all colonels once every week to call together all his captains, and to inquire into all offences in his regiment; to examine the nature and quality of such offences; to prepare the causes for a more speedy hearing, and to repair to the court-martial as often as they shall be warned. The following extract is taken from a work entitled, "*A Brief Treatise of Warr*, &c., by W. T., in the year "of our redemption, 1649." (MS. No. 6,008, Harl.)

"The next in order I conceive to be the President of the High "Court of War, whose place requireth him to be a person of honour "and integritie, of sound judgment, of ripe knowledge in civil and "military laws, before whom all matters civil and criminal that have "relation to the Army are to be tryed, therefore he ought to be "assisted with a learned fiscal or judge advocate, as also with a well-"experienced auditor, to audit and keep a register of all cases and "matters that shall be brought before the Court of War. His office "is to assemble the Court of War as often as the General shall please "for to appoint him; and in the interim he is to prepare all business "and causes, so that the Court of War may have a clear and just "information of all things; and when that any business shall come into "a final sentence, he shall have the privilege of a double voice, because "he represents the General's person."

Towards the latter end of the reign of King James I, and in the beginning of that of Charles I, a kind of mixed court seems to have been occasionally adopted, composed of both civil and military members. Such as when an army was quartered at Portsmouth, Plymouth or Dover, or other sea-ports, waiting to be embarked for foreign service; in which case a Commission was sent down appointing Commissioners to try all offences committed by the soldiers or followers of the Army within certain counties or districts. Many of the Commissioners were military men, but with them were joined the Earl Marshal, Lord Lieutenant of the county, and the mayors, or chief magistrates of the principal towns of that district and its environs. Rymer mentions several instances about the years 1626 to 1640. In the laws and ordonnances of war, published A.D. 1640, by the Earl of Northumberland for the King's Forces, and those of the Earl of Essex for the Parliamentary forces in 1643, all controversies between soldiers and their captains and others, were

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directed to be summarily heard and determined by the Council of War, except the weightiness of the cause required public deliberation. No other court is mentioned.

The Rules and Articles of War in the reign of James II, approach those which are now in force, some of them forming the basis of our present laws. The following directions with regard to military discipline were issued for the use of His Majesty's Forces in 1686:—

Of Councils of War, or Courts-Martial.

"In an Army the Council of War had always to meet at the General's quarters or tent, and none were to be called to it but Lieutenant-Generals, Major-Generals, and Brigadiers. The attendance of Colonels and Commanders was only allowed when the matters concerned their regiments. Private Councils of War or Courts Martial in a garrison were held at the Governor's house; when in a camp, at the Colonel's tent, and he notified to the Captains to be present. The Governor or Colonel, or whoever was to be President, took his place at the head of the table, and the Captains were ranged in order according to seniority. The town Mayor or the Quarter-master of the regiment, who, in the absence of the Judge Advocate, discharged his office, sat at the lower end of the table. First Lieutenants and Ensigns had a right to be in the room, but had to stand at the Captains' backs with their hats off, and had no vote. The Council having been called to deliberate on some matter of importance, the President opened it to the Court, when the opinions of the members were taken in writing,—those of the youngest officers first. The result was decided according to plurality of votes. If the Council of War were held to judge a criminal, the President and Captains having taken their places, the prisoner having been brought before them, and the information read, the President interrogated the prisoner about all the facts whereof he was accused. After the Court had heard his defence, and the proofs made or alleged against him, he was ordered to withdraw, and was remitted to the care of the marshal or jailor. The sentence was decided by the plurality of votes; after which the criminal was brought in and the decision announced in the name of the Council of War, or Court Martial. When the criminal was condemned to any punishment, the Provost-Marshal caused the sentence to be put in execution, and if the punishment were to be public, the regiment was drawn together to see it, that the other soldiers might thereby be deterred from offending. Before a soldier was punished for any infamous crime, he was publicly degraded from his arms, and his coat stripped over his ears. A Council of War or Court Martial was to consist of seven members at least, and, if there were not Captains enough, inferior officers might be called in.

"By 2nd and 3rd Edward VI, c. 2, it was enacted that martial law might be declared by every field officer in every field under his charge once a month, and by every Governor or Captain of a garrison or fortress once every quarter, within his charge. The 5th Philip and

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" Mary, c. 3, established trial by jury for military offenders, unless the " offence was committed during actual service, in which case the Lord " Lieutenant or Lord Warden, or any other chieftain might determine " the punishment, according to his own discretion. The judicature of " the Constable's Court gradually underwent a change. Its power was " exercised through the medium of Parliament, and sometimes, even, " by the civil magistrates."

I now wish to call your attention to some of the peculiar punishments in vogue in those days. Few of the ordonnances of war mention the punishment of death by beheading or hanging. In cases where a large body of troops had been guilty of one common crime, and decimation was resorted to, billets were put into a helmet, every tenth one being marked " D," and those who drew the marked billets suffered the punishment of death. Occasionally the sufferers were chosen by means of casting dice on the drum-head. When an officer had been guilty of blasphemy, his tongue was bored with a red-hot iron. This practice remained in force till the time of Queen Anne. Another punishment sometimes inflicted, was that of riding the wooden horse. This machine consisted of planks nailed together so as to form a sharp ridge or angle, about 8 feet 9 inches in length. It was supported by four posts, about 6 feet 7 inches in height, and was placed on a moveable stand. The punishment of picketing was carried out thus:—A big post was driven into the ground, and the delinquent was ordered to mount a stool near it. His right hand was then fastened to a ring in the post by a noose round his wrist, and drawn up as high as he could stretch. A stump, the height of the stool, with its end cut to a round and blunt point, was then driven into the ground near the post, and the stool being taken away, the sufferer had nothing but this stump to rest on. This severe torture was sometimes continued for upwards of a quarter of an hour. The punishment of flogging was inflicted with switches, and not as in the present day. We have an account of the following punishment being inflicted on an officer after the battle of Falkirk, in the rebellion of 1745. The line were drawn out under arms, the prisoner was brought to the head of the oldest brigade, his sentence was read, his commission was cancelled, his sword was broken over his head, his sash was cut in pieces and thrown into his face; and, lastly, the Provost-Marshal's servant gave him a kick and turned him out of the line. When a private soldier was dismissed, he was drummed out with a halter about his neck.

Still another punishment was that of the whirligig, a kind of wooden cage turning on a pivot, into which the delinquent was placed, and then whirled round with amazing velocity.

The immediate cause of the passing of the first Mutiny Act was as follows:—

The Scottish regiment of Dumbarton when ordered to Holland to replace a Dutch regiment which William desired to keep in England, mutinied at Ipswich, and declared their adherence to the abdicated prince. The King communicated with his Parliament and marched three Dutch regiments against the disaffected troops. The Parliament.

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in order to repress the mutinous spirit of the Army, passed a Mutiny Act, a warrant of unquestioned legality for the punishment of all military feuds. The first regular Mutiny Act was passed the 3rd of April, 1689, and was intended to be in force six months, but excepting during three years of the reign of William it has been annually renewed ever since. It will thus be seen that Military Law executed by the Sovereign is authorized by Parliamentary legislation, and rests upon a basis of undisputed legality. Whitelocke, speaking of the first Mutiny Act quaintly says, "though the King would have the power of the "sword, the Parliament would have that of the purse; so that "they must both agree to draw the sword, or else leave it in the "scabbard, which is the best place for it." Hallam in his *Constitutional History of England*, says, "These are the two effectual securities "against military power; that no pay can be issued to the troops with-"out the previous authorization by the Commons in a Committee of "Supply, and by both Houses in an Act of Appropriation; and that "no officer or soldier can be punished for disobedience, nor any "Court-Martial held without the annual re-enactment of the Mutiny Bill."

I will now turn to our Military Law as it is at present constituted. The definition of Municipal Law is equally applicable to Military Law, it is "a rule of conduct prescribed by the supreme power in a state, "commanding what is right, and prohibiting what is wrong." As also the common law is composed of two elements, the written and unwritten law, so the law military has its written element in the Mutiny Act and Articles of War, and its unwritten part in the usages and customs of the service.

Tytler in his *Essay on Military Law*, says, "The modern British "soldier enjoying in common with his fellow-subjects, every benefit "of the laws of his country, is bound by the military code solely to "the observance of the peculiar duties of his profession, a code which "is simple in itself, reasonable in its enactments, easy in all its obliga-"tions, level to the meanest understanding, and more effectually "promulgated and better known than any of the ordinary statutory "laws of the realm."

I had the privilege of hearing the charge of the Lord Chief Justice Cockburn (the very highest authority in the common law), to the grand jury, in the case of the Queen v. Colonel Nelson and Lieutenant Brand. Unhappily it has not been published, but I made notes of it, and can vouch for the substance of his expression. He said that the Mutiny Act and the Articles of War are so elaborate and precise, that it is impossible for any one who looks into them with the view of ascertaining what his duty is, to fail in discovering it, or in finding out what the law is by which he is to be guided. There is nothing arbitrary in the military law, it is precise, specific, and defined.

We will now take the side glance I mentioned in my opening observations, at the various modern systems of military law in other countries, in France, Austria, Prussia, and the United States.

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France.

Conseils de Guerre, are composed of seven judges, assisted by
A Commissarie Imperial.
A Rapporteur,
A Greffier.

From the rank of private to that of captain, the composition of the court is:

1 Colonel—President.
1 Chef de Bataillon ou d'escadron.
2 Capitaines.
1 Lieutenant.
1 Sous-lieutenant.
1 Sous-officier.

The following is a brief sketch of the mode of procedure in a French Military Court. The complaint is drawn out by the captain, and the attendance of witnesses secured. This is sent to the *Chef de bataillon*, who forwards it to the Colonel, the Colonel sends it to the Lieutenant-General, the General to the Conseil de Guerre. When the court is held the Commissaire de l'Empereur attends to see that the proceedings are conducted according to law, and when required, to read the text of the law applicable to the case. The prisoner is interrogated by the rapporteur, who has to prepare all the proceedings and enlighten the council in the performance of their sacred duty. A member of the bar may be appointed to defend the prisoner, and the verdict is decided by a majority of at least five out of seven.

Punishments are very severe, but no flogging is allowed.

In Austria each regiment has its regimental Auditor, who must have passed an examination, and taken a degree of doctor of law. He ranks with and wears the uniform of a captain. His duty is to examine into all cases of prisoners sent for trial, to sift and prepare the evidence, and exclude all irrelevant matter. When the court assembles, he explains the nature of the case, the laws affecting it, and the particular points to be decided. He is expected to keep before the consideration of the court all the points which bear in favour of the prisoner. In fact, he has to transact all the business of a legal kind which may affect the regiment, and to keep historical records of these transactions. There are two kinds of courts martial, a full court for grave offences, and a lesser court. The former consists of two officers of each rank from princes to captains. The Field Officer presides, and the court has the power of life and death. In the latter court the members consist of one of each rank, from that of the man to be tried up to the captain who presides.

A Prussian court martial consists of a captain, who presides, two first lieutenants, two second lieutenants, two sergeants, two corporals, two acting corporals, and two privates. The witnesses are examined

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by an officer called an examining officer. When the prisoner is a sergeant, the acting corporals and privates are not admitted, and when he is a sergeant-major, corporals are also excluded.

In Prussia there are seventeen schools for military education, in which special attention is given to military legislation.

The United States.—The Articles of War and procedure of courts martial are very similar to our own in the United States. With their courts a Deputy-Judge Advocate is still the prosecutor. No flogging is allowed.

I will now venture to bring before you the outline of a scheme which, if carried out, I cannot but think would tend to the gradual removal of those defects which exist in our mode of procedure in courts martial, and would raise the whole tone of our military legislation. I have much distrust of myself as the medium of bringing my thoughts before you, but I have a conviction of the necessity for their application to the present state of things. The plan I would humbly venture to throw out as a suggestion, is that it would be in the interest of the Service, for the Government to announce their intention of forming a body of Officers possessing the necessary qualifications for the confident performance of the duties now required of the Deputy-Judge Advocate, and such other legal duties as the Service might require.

Candidates for this body should be officers of ten years' standing, or who have passed the Staff College. They should be examined in the Mutiny Act, the Articles of War, Procedure of Courts Martial, the usages and customs of the Service, and in the knowledge of military law, which they would acquire while doing duty with their regiments. A certain number should be selected and exempted from military duties for one year to attend classes connected with the Inns of Court on such subjects as Common Law, Constitutional History, and International Law. They should attend the Criminal Courts and study the rules of evidence, the formation of judgments, and the manner of conducting judicial investigations. At the end of a year these officers should undergo an examination, and, if found qualified, should be employed as Deputy-Judge Advocates, or, until they obtained such appointment, as Prosecutors at General Courts Martial. In course of time they might be required to assist at Garrison as well as General Courts Martial. No doubt the Council of Legal Education would meet the military authorities, and grant facilities for these students, such as not requiring them regularly to join the Inns of Court. They should have access to the records in the Judge Advocate's office.

In common with all readers of military history, I have profound respect and admiration for Sir C. Napier. Major Hughes, in his book on the duties of Judge Advocate, quotes Sir C. Napier, as giving this recommendation, "That no man should be appointed, either to officiate, "or be permanently posted to the Judge Advocate-General's Depart-"ment, till after a certain length of service as a Regimental Officer. "That previously to his entering on his duties, a Judge Advocate "should undergo a strict examination as to his knowledge of military "and criminal law, and the practice of military courts"

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Major Hughes, D. J. A., also writes:—"I do most decidedly assert "after some little experience in the department, and not without "giving the subject the deepest consideration, that the duties of Judge "Advocates in the present day require qualifications and attainments "which are not to be obtained without instruction and a regular course "of study, to which must be added, if proficiency is an object, assi- "duity and research."

I do not claim any exclusive originality in this idea. I suppose most military men who have thought much on the procedure of our Courts Martial, have seen that there is room for improvement in it, and they would rather look to members of their own profession for this improvement than seek it from the bar, while on the other hand most of the legal writers on our military law have suggested that lawyers should either preside or act as assessors to military courts, as the means of perfecting their procedure. I find that a military writer in the *Law Magazine* suggests a plan very similar to the above, though of course he does not write of my special scheme, of Officers keeping classes at the Inns of Court as a good means of qualifying themselves for their varied legal duties. The article is "On the real character of Courts Martial "and their proposed Reform." The author having argued strongly against courts martial being placed under civil control, in which I entirely agree with him, proceeds,—"Why not train a class of officers "to act, if not as chairmen of Courts Martial, at all events as asses- "sors?"

"The exclusive appointment, moreover, of military men to these "responsible positions, would be a great incentive for officers generally "to acquire a thorough knowledge of military law, and of the proper "mode of conducting judicial examinations."

I cannot but think, that if Officers of some standing were to give up their ordinary avocations for a year, and devote themselves to these studies, their doing so among regular law students, and under the instruction of the distinguished Readers of the Inns of Court, in fact, their breathing the legal atmosphere, would materially lessen their difficulties in acquiring that legal acumen which might be of important advantage to their Service. I have been long enough in the Service to know that, were such a scheme as I have suggested carried out, many, perhaps not ill-naturedly, would carp at men being taken from their regular duties for a time to qualify for good appointments; and they might say it was a good slope—a good way of getting a year in town. This sort of thing can be well refuted by looking at the prospectus of the classes, which the scheme suggests should be kept. The best part of every day in the week is occupied with the classes during the Term; and when the classes are not going on, attendance at the Criminal Courts, and the acquisition of the requisite knowledge, would abundantly occupy the time of these military law students. I take this opportunity, and I do so with much pleasure, of paying my humble, but hearty, tribute of praise and thanks to the legal profession, with whom I have now for some time been associated. Coming among them as I did a perfect stranger, having all my life followed such entirely different pursuits, I have found nothing but kindly courtesy

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and willing help, not only from the students with whom I have necessarily been most associated, but from the Bar, the Readers, and even the Benchers and Masters of the Temple. Officers keeping these law classes and acquiring thereby a sort of legal acumen, would not imperil their efficiency as Officers and soldiers. On the contrary, the skill which they would acquire in investigating facts brought before them would be of use in strategic arrangements, and help to prompt decision in tactics before an enemy. Were this body of Officers formed, in course of time every garrison and colony would have at least one of them. I cannot but believe, that on occasions of difficulty or disturbance arising, it would be a great satisfaction to Governors of Colonies or Generals in command, to know that they had an Officer who had made law his especial study, and whose counsel might be relied on, and in any peculiar emergency, might be felt more desirable than that of the ordinary law advisers; not that I would suggest that these Officers should be wholly responsible Officers, but that from their having successfully carried out a course of legal study, they would be qualified to give to their chiefs a valuable opinion. Newspapers have of late frequently made severe criticisms on our Military Courts, and their mode of procedure. Those remarks have often been characterised by powerful writing, and by considerable ignorance of the subject they maligned. Still, in these days, when papers are so much read by the public, and so much in the hands of our soldiers in their recreation and reading rooms, it would be well to obviate these censures on our military legislation, and to endeavour to raise its tone by forming such a body of Officers as I have suggested. I said in my opening remarks that I would not presume to put forward my own opinions as to the merits or demerits of military law, nor will I. I will only say that the mere establishment of such a body of Officers would in itself lead to the introduction of such improvements or alterations as may be needed in our military law and its administration. I know many will say that the present system does well enough, and that at the Staff College there is a special class for military legislation. Every one must have the highest respect for the varied attainments of those Officers who have passed through the Staff College; but for the very reason that their studies are so varied, I maintain that sufficient special attention cannot be given during the course at the College to the qualifying of an Officer for the confident discharge of the manifold duties of a Judge Advocate. I lately met with a story of a traveller who came to a well, and noticed a maiden weeping beside it. On his inquiring what was the cause of her grief, she replied that she wept because she was thinking she might get married and have children, and one of them might fall into this well. Is there not too much of this anticipation of improbable evils? It may be dreaded, that if this scheme were carried out, the "law's delays," with legal quibbles and technicalities, would creep into our Courts Martial. Is it not better to see that the Service would gain Officers who had exercised judgment in disrobing facts of appearances which do not belong to them, and in dissevering them from others with which

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they have no essential connection; and so, often might be prevented that most deplorable of all the consequences of human fallibility, viz., the condemnation and punishment of the innocent, and, next to it, the suffering the guilty to escape conviction. I have to thank the Council for permitting me to address you, and I hope they may extend their kindness by permitting some portions of what I have put forward to appear in our Journal, that perhaps its wide dissemination may bring these imperfect suggestions to the notice of those who, from their knowledge and position, may improve on them and promote their adoption.

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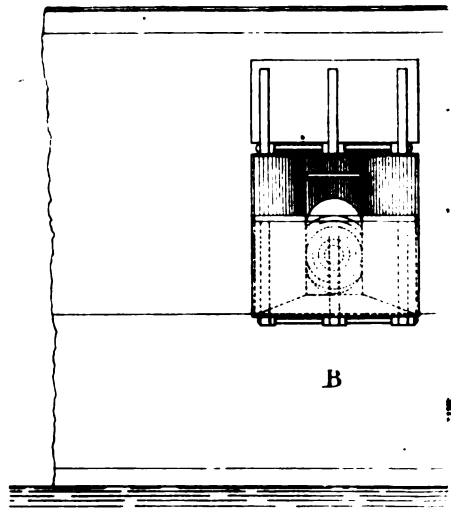

Elevation of recessed Port with Embra
Port recessed 2 feet

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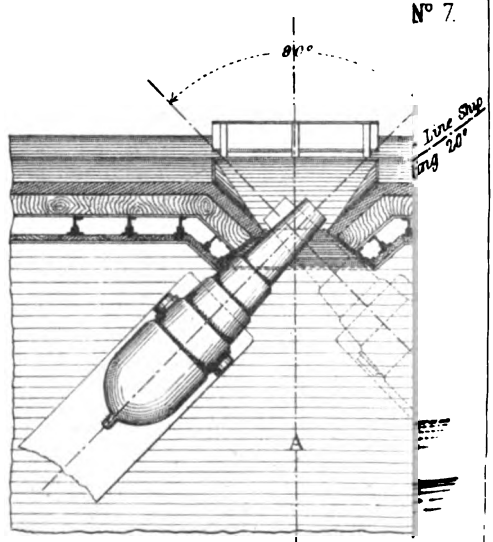

Plan of Recessed Port shewing arc
Port recessed 2 feet

J Jobbins

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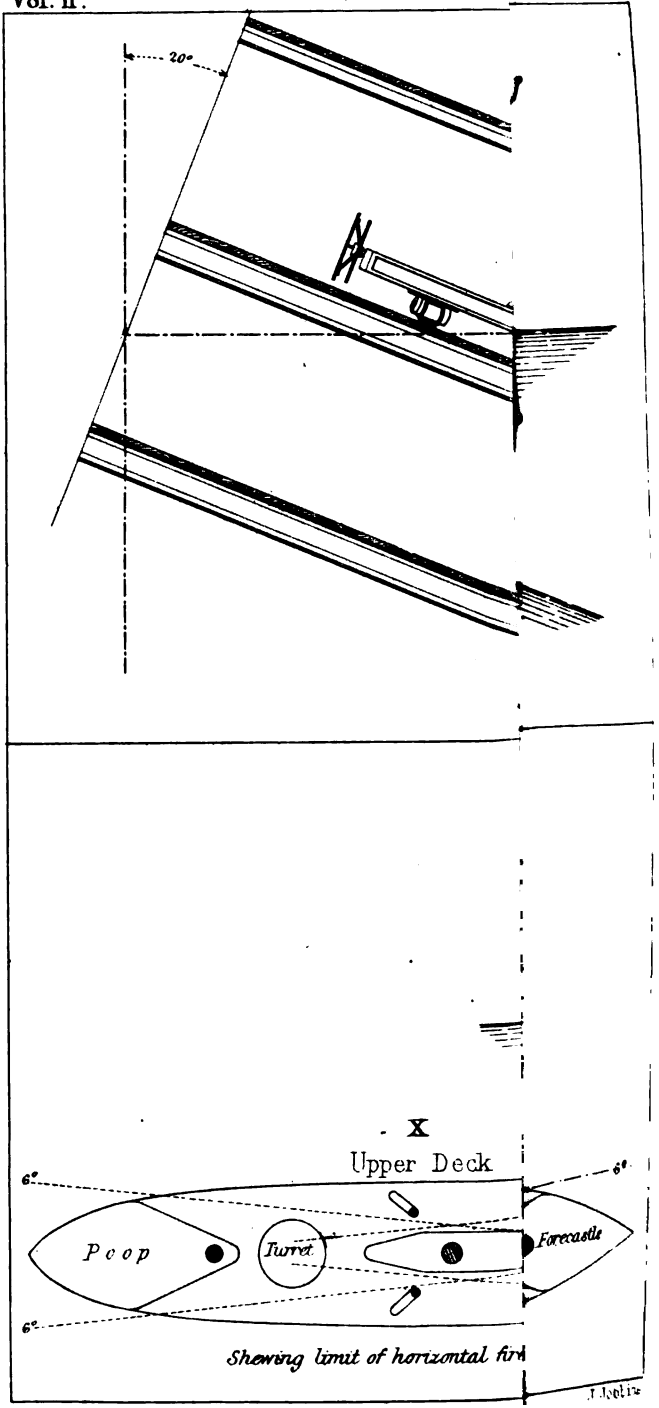

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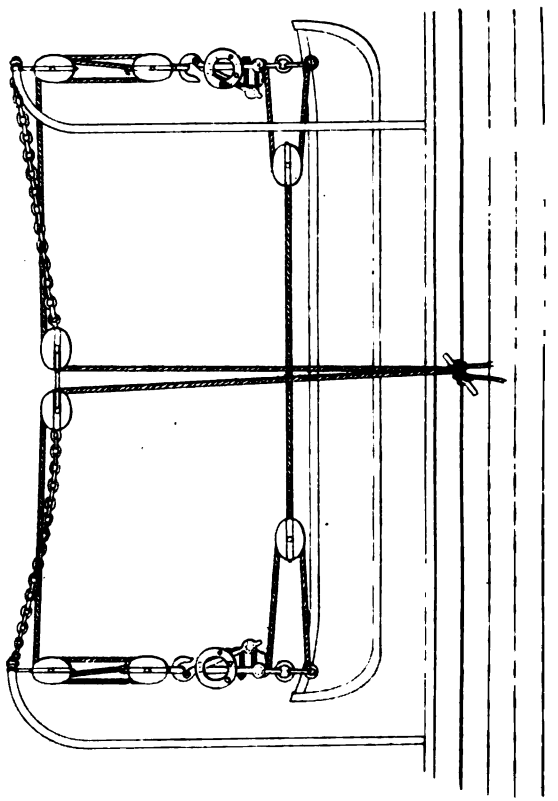

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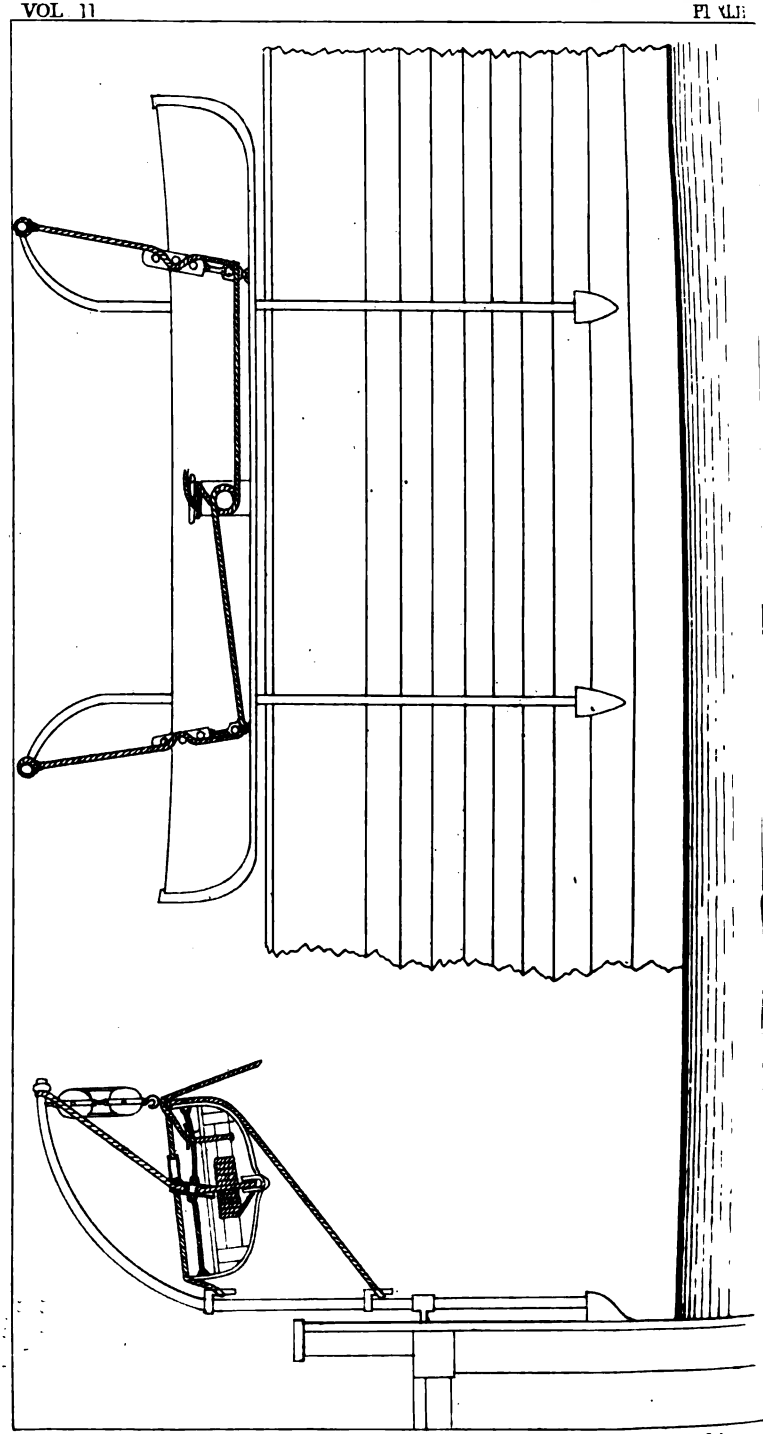

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The Journal
OF THE
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VOL. XI. 1868. No. XLVII.

LECTURE.

Friday, May 10th, 1867.

W. STIRLING LACON, Esq., in the Chair.

SUSTAINING AND LOWERING SHIPS' QUARTER-BOATS.

By Captain C. B. SIMPSON, R.N.

MY position this afternoon—that of advocate in my own cause—is one so well understood by Members of this Institution, that I feel an apology to be superfluous. I will, therefore, at once proceed with the object I have in view, viz., that of introducing to your notice a plan for hoisting, sustaining, and lowering quarter-boats at sea; and by comparing it shortly with the modes at present in use on board Her Majesty's ships, endeavour to bring out the relative merits and defects of the different plans.

The plans at present in use are, Captain Kynaston's and Mr. Clifford's.

Captain Kynaston's plan will be best understood by reference to the drawing (Plate xli); and, as will be seen, it retains all the old arrangement of falls, grips, &c., simply substituting his disengaging hooks for the common hooks. The operation of lowering, in his case, is this:—On the boat being required, after the crew are in the boat, the grips have to be cast off, and the boat lowered by the falls in the ordinary way; a third man in the boat being required to attend the disengaging-line, which, when let go, disengages the boat. There are, therefore, after the grips are cast off, two, if not three men, necessarily employed in the operation of lowering. The principal objection, however, to the plan is, I think, its complication, and the number of moving parts dependent upon each other for safe and accurate working. For instance, there are no less than five different ropes, two falls, and three different parts of the disengaging lines, with four ends belayed to different cleats, any accident to any one

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of which, by slipping, by carrying away, or by unequal lowering of the falls, or easing of the disengaging lines (which depend for their equality of working upon the freedom from rust and perfect order of no less than two sheaves and two bearings in each hook), would be the cause of serious accident.

In addition to which, notwithstanding the claim made to the contrary, I consider these hooks to be most clumsy and difficult to handle for hooking on in a sea-way; it is true that when once hooked, and the lines hauled taut, and the relieving-bolt in, that the boat will not again become unhooked; but two men are required to each hook to perform this operation, one to attend the hook, and the other the disengaging line, and I think the following paragraph, from Captain Kynaston's paper of explanations, will convey some idea of the difficulty likely to follow from the necessity of requiring two men to take the boat at the right bob simultaneously.

The hooks for hoisting boats should be always attached to the boat's slings—never to the tackles. Any one who has been bobbing about in a boat, under a ship's davits, vainly endeavouring to hook her on in a sea-way, can speak feelingly of the risk a boat and her crew have to encounter at every surge, from the playful sallies and tenacious grip of the hooks, when fitted in the usual manner to the boat's tackles. To disengage suddenly, under such circumstances, from a ship moving through the water, or indeed when stationary would be fraught with the greatest danger, whatever kind of hook be made use of.

Mr. Clifford's plan, as shown in Plate xlii, is as follows:—A roller is fitted in the centre of the boat, which works freely in bearings at each side of the boat under one of the thwarts; to this roller a rope is made fast, and wound on it to a length equal to the distance the boat will have to descend from the davits to the water. Two single ropes or pendants are made fast to the davit-ends, and rove through the three-sheaved blocks attached to the boat-slings, then through the leading blocks at the bottom of the boat, and the ends of each are entered through the same hole in the roller, but in opposite directions. By hauling on the lowering-line, before mentioned, which is wound on the roller, the pendants will be wound on the roller to the same extent that the lowering-line is unwound. The three-sheaved blocks act so as to nip the pendants, breaking the strain to the man lowering, and giving him control over the descent of the boat, whatever its weight may be. The nip of the three-sheaved blocks only exists so long as there is any strain on the pendants passing through it, and ceases on the lowering-line being let go on the boat reaching the water.

The grip is made in two parts, with thimbles at each end, and held together by a lanyard.

When the boat is hanging on the pendants, the grips are passed round the boat, and the thimbles are passed up the prongs attached to the davits for that purpose, the lanyard is then hauled taut, and thus the boat is secured to the ship's side.

When the boat is lowered, the thimbles slip down the prongs, and the boat is free.

Here, I think, we have a great advantage, at any rate as far as the lowering is concerned; for though there are still three different ropes

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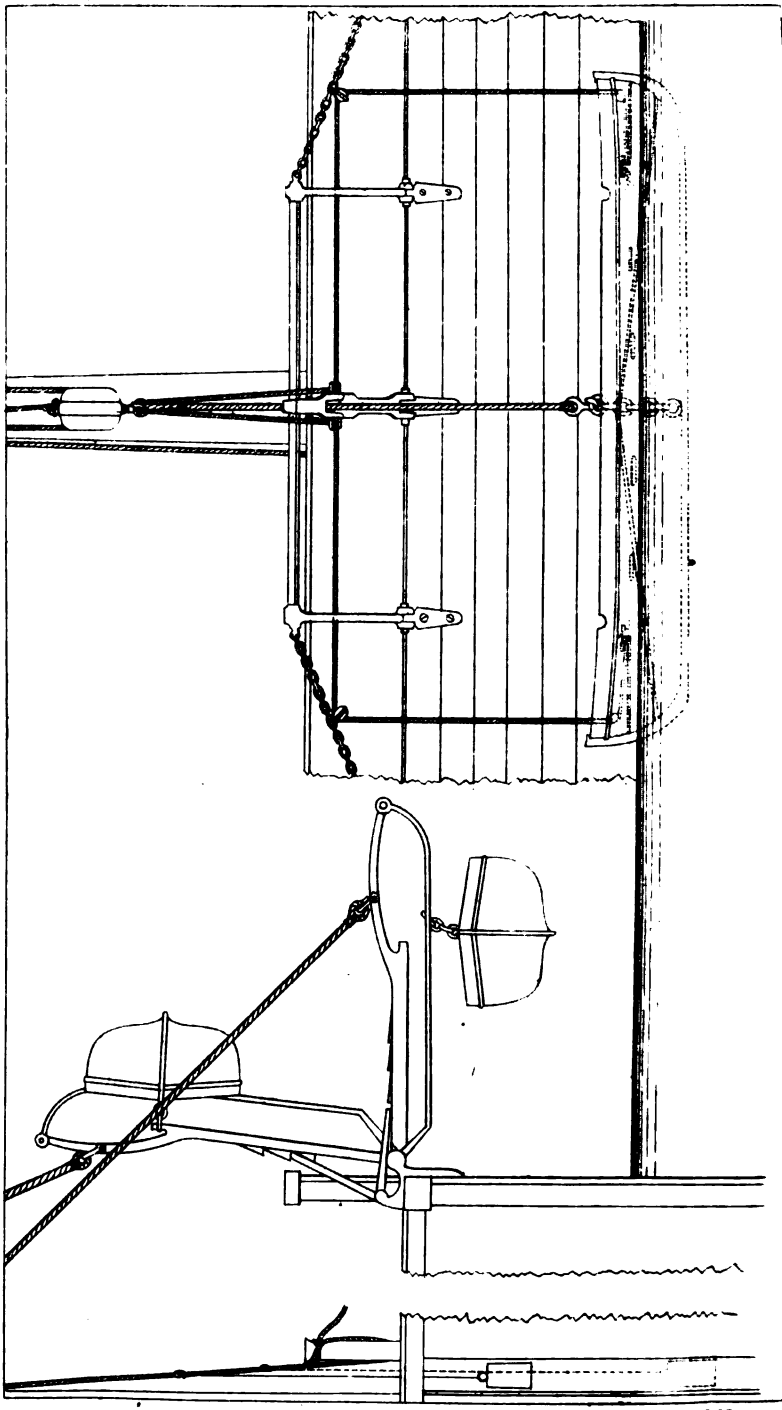

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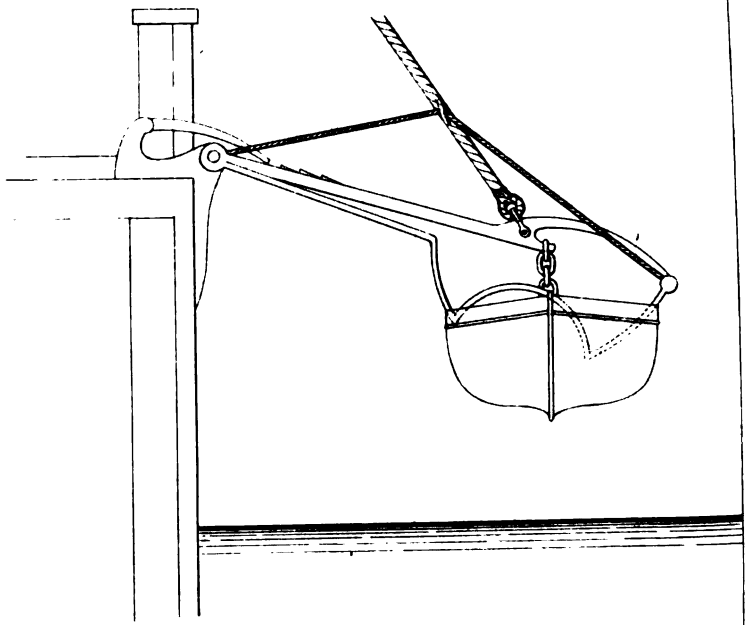
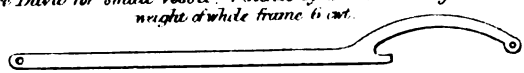
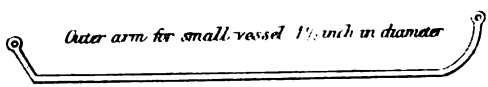
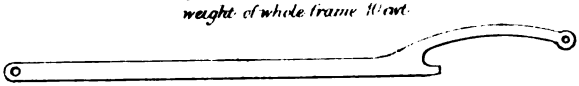


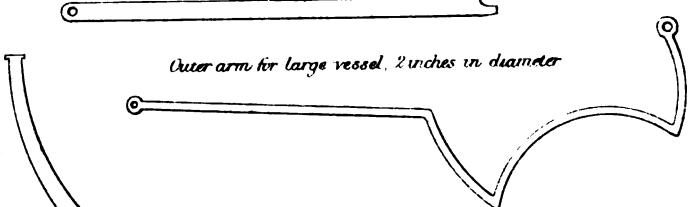
Centre Davit for small vessel, 4 inches by 3 whole length 10 feet
weight of whole frame 6 cwt.



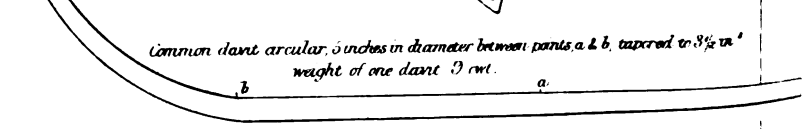


Centre davit for large vessel, 5 inches by 4 whole length 12 feet.
weight of whole frame 10 cwt.





Common davit circular, 5 inches in diameter between points a & b, tapered to 3½ in.
weight of one davit 9 cwt.



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employed in the operation of lowering, an accident to any one of which would be fatal, yet they are all under the control of one man, and he has only to perform one operation in lowering the boat, viz., to ease away the lowering-line, and if the tapered pendants will always unreeve clear from the roller, the plan, as I said before, as far as the simple lowering is concerned, is excellent. But I still venture to think that there are serious objections to the plan as a whole.

Firstly, the space occupied in the boat by the roller, interferes materially with the boat's stowage, and there is the chance of fouling the pendants when lowering, if the bottom of the boat is not kept clear.

Secondly, I believe the plan of the grips to be most injurious to the boat, and dangerous to the crew when lowering.

A few words will explain what I mean.

It is evidently not only advantageous, but absolutely necessary, that the davits should be made to carry the boat as far out from the ship's side as possible, to prevent, as far as may be, her being stove when being lowered or hoisted in a sea-way. It will also be seen, that if the least play is allowed to the boat by the grips, the latter, if the ship rolls at all heavily, will become unhooked, consequently it is necessary for the boat's safety, that she should be bound by the grips taut up against the davits, so as to preclude all play; but the result of doing this is, that in a short time the gunwale of the boat becomes completely crushed in by the grips, and the boat is rendered useless. This statement may appear an exaggeration, but I can answer for its having been the case in the last vessel I commanded, and also am informed that it was the case with several others on the same station.

These grips are also dangerous; for if, when the boat is bound up against the davits, as before stated, the lowering-line is eased away, the boat, when the grips slip off the spurs, will swing violently outward, especially if the ship is rolling heavily at the time, and the send of the ship happens to coincide with the swing of the boat; and if the boat is not rapidly lowered, so as to reach the water before she returns towards the ship, she is in great danger of being stove against the side.

Thirdly, there is not only no advance on the old plan of hoisting up, but there is a serious additional drawback in the length of time that the boat must necessarily hang unsecured after hoisting, whilst the pendants are being rove, and the tedious operation of a second hoisting is going on, this being rendered necessary in order to get the pendants sufficiently taut to hang the boat the required height.

It was my practical experience of the defects in the plans I have shortly put before you, that induced me to try and devise some plan that should obviate them. The result of my endeavours I will now bring before you. I must ask you, however, gentlemen, not to expect perfection; no doubt if I have succeeded in obviating some of their defects, I shall have introduced others; but I shall be satisfied if the relative advantages of my plan outweigh, in however small a degree, its disadvantages.

My plan (see Plates xliii, xliv) consists of three arms or davits combined, and acting in one frame, these arms are each jointed to brackets

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or knees fixed to the side of the ship, and are placed at equal distances apart. The joints of all three being in the same horizontal line, the davits are free to describe a semicircular arc; that is to say, they may fall down against the outside of the ship, and be raised upwards and inclined inboard over the bulwark. The middle arm is the strongest of the three, having to support the principal weight of the boat, which is supported therefrom by a straight hook, or spur-like projection, or tongue, formed on the under side of it, about two-thirds out. The other, and extreme arms, are each in one of the forms shown in the drawing; the plain straight one being intended for small vessels, where the davits will not be required to be lowered below the horizontal. The other, applicable to large vessels, having their outer ends formed as portions or segments of a circle, round which the gunwale of the boat glides when the davits are lowered beyond the horizontal; the boat is thus in both cases kept firmly in the horizontal position until the ring attached to the boat's slings, by which she is suspended, slips off the spur by reason of its incline, when the boat is free. The extreme ends of the arms are connected by a suitable tie-rod, so that all three arms move together on their hinges as one frame, and the whole is raised or lowered by a single rope or chain attached to the centre arm, led up to the mast or other standard over a pully, and down to the deck to a point where it can be eased away with certainty and facility. A counterweight, sliding freely in a tube placed up and down the mizen-mast below the deck, as shown in the drawing (Plate xliii), is attached to this chain or pendant, acting upon it within certain limits, so as to ease the descent of the boat, and to raise the davits, immediately they are relieved from the weight of the boat, to the hoisting position.

A sheave is fitted in the centre arm, near the position of the supporting hook, or spur, over which sheave a rope or pendant is rove, for the purpose of hoisting the boat into position, to be supported by the davits. Thus both, when hoisting, and when the boat is in position, the davits act as a derrick to keep the boat out from the ship's side, the weight of the boat being almost entirely thrown upon the mast or standard.

The boat is suspended by longitudinal and cross slings from either end and side of the boat, which are secured to a ring, and slung amidships, the whole terminating in a single ring, or hook, by which the boat is hooked on to the lifting pendant. A second ring is connected with the slings, which is to be placed on the hook, or spur, before mentioned, and by which the boat is wholly supported when fixed in position. The slings supporting the boat have a part carried down to the keel of the boat, by which the more direct weight is supported.

The hook or spur which supports the boat is made either to project in a line with the mid-arm, or is inclined a little to its plane, according as it is determined to detach the boat before the davits arrive at, or after they have passed beyond, the horizontal position. On each side of the central arm also, abreast the sheave before mentioned, are two small rollers, underneath which two steadying lines, which are spliced into the upper eye of the hoisting pendant, are rove, and led through

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blocks on the fore and aft guys, so as to plumb the bow and stern of the boat, so that when hoisting, as soon as the hoisting pendant is hooked and hauled taut, the steadying lines, which have been previously rove through small eyes or blocks at the bow and stern of the boat, are hauled taut, and a turn taken with them. The boat will then be hoisted steadily out of the water, all three ropes rising exactly at the same speed, until the gunwale comes in contact with the extreme davit arms, when the ring before mentioned is placed over the spur on the central davit. The hoisting pendant is then slacked up and unhooked, and the steadying lines unrove from the boat, when she will be firmly secured to the davits by her own weight, without the aid of grips, and be ready for lowering.

Grooved chocks are fitted on the inside of the gunwales of the boat to receive the extreme davit arms, and prevent any motion being given to the boat by the pitching of the ship.

Teeth are provided on the mid-arm, and a paul, by which the position of the davit frame is regulated.

When it is desired to lower the boat, it is simply necessary to ease away the single supporting rope or chain, so as to lower the davit frame outwards, until it reaches a certain predetermined position, when the ring supporting the boat from the hook or spur will slip therefrom by reason of its inclination, while the boat will be free to fall into the water, and this without the possibility of mischance.

I think it will now be sufficient for me to point out shortly some of the advantages I believe my plan to embrace, and hold myself in readiness to answer, as best I may, the objections to it that may occur to my hearers.

1stly. There are no extra fittings or gear in the boat to interfere with the stowage.

2ndly. That there are no grips to cast off.

3rdly. That in lowering there is only one operation to be performed, by one man, viz., easing away the topping lift, and this not amongst a confused heap of men just bundled in the boat, as in Clifford's case, but on the deck of the ship, apart from all confusion.

4thly. That the boat is kept rigidly in position on the davits up to the moment of her release.

5thly. That from the fact of her being attached from one central point only, there cannot possibly be any irregularity in the operation of lowering, but that the boat must fall into the water on an even keel, neither will the motion of the ship (except to a small extent, to be hereafter explained) alter the predetermined height from the water at which the boat is to be freed.

6thly. That no plug is required; the boat is cleared of water by simply topping the davits.

7thly. That the boat is carried by the action of the davits when lowering completely clear of the ship's side.

8thly. That the davits will, in hoisting, keep the boat so far from the ship's side, and, from being nearer to the water when in position for hoisting than the old davits, give the boat so much less play as to preclude the possibility of her being stove.

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And, lastly, from there being only one single hook to hook on for hoisting, the danger and delay from first one fall and then the other becoming unhooked, and the necessity of keeping the falls clear of turns is avoided.

I wish to call special attention to the hoisting, as I believe that by the adoption of my plan, hundreds, if not thousands a-year, would be saved to the country which are now spent in the repair of boats, stove in hoisting; besides the inconvenience and delay to the service thereby entailed.

Before concluding I must refer to one important point. I have said "neither will the motion of the ship, except to a small extent, alter "the predetermined height from the water at which the boat is to be "freed."

Now, it is evident that if the davits could be hinged to the centre of motion of the ship that no variation could take place in the predetermined height from the water at which the boat is to be freed; whatever the list or rolling motion of the ship might be, that height would remain the same, whether the boat were brought to it by lowering the davits, by the inclination or roll of the ship, or by both combined.

But unfortunately the davits cannot be hinged to that point, but must be hinged to the side of the ship. What then will be the effect of this?

I will take an example to illustrate it. Supposing a ship of 36 feet beam abreast the mizenmast to have her davits hinged to the side 10 feet above the water line, a list of 15 degrees will elevate the davits on one side about 5 feet higher above the water than when she is upright, and bring the other, or opposite, davits the same distance nearer to the water level. Now, suppose the tongue or spur on the davit from which the boat is suspended to be placed at such an angle as to free the boat when the ship is on an even keel, 5 feet above the level of the water, we should have, when the ship is heeling 15 degrees, to drop the weather boat 10 feet, and the lee boat would be freed just as her keel touched the water.

If the ship was rolling 15 degrees each way, either boat would be freed at some intermediate point between these extremes.

Now, taking for granted, as I do, that a maximum drop of five feet for a boat, could never cause her the slightest injury, all that we have to do, is to place some permanent stop on the topping lift, by means of a toggle, or any simple plan, so as to preclude the possibility of the davits being lowered beyond the position they would have to attain, in order to free the boat when the ship is upright; and to make the rule, that when under sail with a steady list, the lee boat is to be used. The boat will then be invariably freed at some intermediate point between the water line and five feet above it; and be it remembered, that no error in judgment in the man lowering can alter this—his judgment has nothing to do with it, and the boat will be lowered with the same ease and safety on the darkest night as in broad day.

It may, however, be asked, suppose the ship to have a steady list of more than 15 degrees, what would be the result?

I would answer, that in our example we have the keel of the boat

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only brought on a level with the water with a heel of 15 degrees, and that the ship will be required to heel some 20 degrees before the boat will be sufficiently buoyant, by reason of her immersion, to prevent the davits descending to the required angle to free her. Also, that unless the water is as smooth as this table, a minimum heel of 20 degrees can hardly be conceived, especially in the present days of under-masting; but even if such a case could occur, the boat would almost invariably be released on striking the water, even if the davits had not reached the required angle, and in any case, no harm could happen to the boat or crew, for as long as the boat is attached by the ring to the davits she is kept firmly in position by them, and by reason of the counter-weight will float far more lightly and buoyantly on the water than if free, and consequently will tow in that position with perfect safety; and if (as, however, is impossible) the ship should not right sufficiently to free the boat, by simply pulling up the topping-lift the boat will be hoisted into position again, and secured. The boat will in such a case have failed in her object certainly, but she will have sustained no injury, and the crew will be safe.

I think I have now touched upon all important points, except perhaps those of weight and expense.

The weight of the davits in my plan will, I think, certainly be less than that of the present ones. Firstly. For the reason before stated, that the centre arm, the only part of the davit which bears any of the weight of the boat, acts simply as a derrick, and is in no case subject to any cross strain, the outer arms acting simply as guides and steadying bars to keep the boat in position. Secondly, that the length of the davit arms need only be about half the length of those at present in use in small vessels. For instance, in the example before us, I would propose that the extreme length of the davits should be ten feet. This would drop and hoist the boat 7 feet clear of the ship's side, and carry her, when topped up, a clear 15 feet above the water.

In point of expense, I do not anticipate any material difference from the present methods.

The CHAIRMAN: I should like to ask Captain Simpson whether he has tried this plan practically; whether he has fitted it to any ship.

Captain SIMPSON: No, I have not; I have only tried it on a small scale.

The CHAIRMAN: You spoke of the ship's davits being only ten feet in height above the water; are not line-of-battle ships' davits very much higher out than that?

Captain SIMPSON: I think the days of line-of-battle ships are rather gone by; but, of course, the higher the vessel, the longer she would require the davit to be. The length of the davit would have to be proportioned to the height of the ship out of water. If the davit were fixed only about 10 feet in height above the water, the length of the davit would be 10 feet; if it was needed 14 feet in height, its length would have to be 14 feet. A davit only 10 feet in length will carry its boat 15 feet above water.

The CHAIRMAN: Supposing you had an order from the Admiralty to

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fit your plan to one of their largest ships, where would you fit your davits?

Captain SIMPSON: So as to drop the boat about six feet from the water.

The CHAIRMAN: Would not your davits come very low down?

Captain SIMPSON: Not necessarily. It depends upon the length of the davit. You can bring your davits close to the water if you like. I consider it perfectly safe to drop a boat 5 or 6 feet.

The CHAIRMAN: Would it not hurt a heavy boat full of men to drop that distance?

Captain SIMPSON: I think not. Five or six feet, I think, is perfectly safe.

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Evening Meeting.

Monday, May 20th, 1867.

CAPTAIN FREDERICK A. B. CRAWFURD, R.N., in the Chair.

FLEET MANŒUVRING.*

By Commander POWNOLL W. PELLEW, R.N.

AT the commencement of a paper on so important a subject as the evolutionary system proposed for the future manœuvring of our magnificent steam fleets, it will be right, I think, to enter a disclaimer against being thought to assume any more special knowledge of the subject than can easily be acquired by any one interested in so doing. There are, however, a great many of my brother Officers who doubtless have not had the same opportunities of gaining experience on the subject that I have had; and to them and any others who may think the matter of any importance, I will address myself.

On joining Sir William Martin, in 1861, as his flag lieutenant, I found him employed on the revision of the present system of evolutions, and consequently for the next two years I was also employed on that subject, during which time, one written and three printed editions of a revised system, intended to suit the requirements of the present day, were brought out.

During those two years, we had not only had the advantage of a considerable amount of steady practice with the squadron itself, in the Bay of Naples, but also of a constant series of exercises with the boats of any of the ships chancing to be in company with the flag-ship. Officers employed about it will not easily forget the continual cruizing up and down Malta harbour, or about the anchorage at Corfu; while, as a further means of ventilating the subject, before and after nearly every practice, the Officers detailed for that duty used to assemble on board the flag-ship, where proposed evolutions would be discussed, and opinions be freely asked and given.

* The sketch here given, is immediately to be followed by a publication on the same subject, going into the whole of the propositions in detail. 8th Nov., 1867.—P.W.P.

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The Admiral had also the satisfaction of receiving opinions highly favourable to his views, from the Captains of the ships composing that squadron of evolutions. The book, however, was not approved at home, and I dropped the subject until April, 1865, when I was appointed, together with Commander Colomb, to assist Sir Sydney Dacres in a contemplated total revision of the Naval Signal Books. Unfortunately for me, however, after about six weeks work, my health broke down, and I was forced to give up my appointment, not, however, before having had the opportunity of seeing and taking notes of all the propositions on the subject that have from time to time been presented to the Admiralty by many distinguished officers.

With this short preface, I now propose to bring to your notice, and explain in as brief a manner as possible, the formations and evolutions, that seem to me to be absolutely necessary for the proper manœuvring of steam fleets. It is not, I fear, a subject that can be made particularly interesting. I am not going to slip into it any reviews of old naval battles, nor, even if I had any, am I going to launch my ideas as to the manner in which new ones are to be fought; I propose simply to sketch out a plan, by means of which I consider a fleet may be kept perfectly in hand, while being manœuvred with the utmost possible rapidity and freedom.

The first point in order, will naturally be the proposed sub-division of the fleet, and in immediate connection with it, the various formations that it would be advisable to provide for.

The present organization divides the fleet into two divisions, and each division into two sub-divisions; or into three squadrons, and each squadron into three sub-squadrons. A sub-division and a sub-squadron are therefore two different things, and it is a very difficult matter, as has often been proved, to work the two arrangements together. It is also inconvenient, and seems like a mistake to have arranged, that the half of the fleet should only be sub-divided into two parts, while the third of it, is sub-divided into three. Thirdly, it is impossible with such a subdivision to arrange any convenient plan, by which the fleet can be passed from two to three, or from three to two columns.

As a complete remedy for all this, I should propose that the fleet should be primarily divided into six sub-divisions, three forming a division, and two a squadron, the unit or sub-division of each of which being the same, does away with the old jumble of four sub-divisions, and six or nine sub-squadrons, and enables an additional order of steaming, "that in sub-divisions" to be provided for use, if required.

This sub-division of the fleet almost settles for us the character of the formations we have now to arrange. For as it is difficult to think of anything more manageable in the way of a formation, than one or more columns, and as a small fleet would naturally be in one, a little larger in two, and larger again in three, it is evident that such a subdivision as I have described, will exactly suit this arrangement. I say a fleet is formed naturally into columns, by which I mean ships at equal distances apart, ranged on one line; for though we hear of double lines of bearing and indented lines, yet these are looked on merely as exceptional formations, and in the case of the latter at all events will, I

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am sure, be found totally unsuitable to the requirements of the present day.

It will further be found on examination, that, to enable a fleet divided into more than one column, to be manœuvred with the greatest facility, the columns should be opposite each other, and at a distance apart about equal to their length.

For general purposes, I should consider the three formations described above, as a sufficient number of what may be called "general formations;" but as we have a further division into sub-divisions ready provided, and as such a formation might in exceptional cases be useful, I should include an order in sub-divisions, on the same footing as the others.

I have especially restricted to three the number of columns in which a fleet should be usually manœuvred, because everything seems tending to the belief, that fleets in future are not by any means likely to consist of so large a number of ships as formerly; more particularly as I should propose that fleets of any size should invariably be divided into two or three small fleets, capable of being manœuvred separately, and thus so reducing them in size, that the one, two, and three columns, formerly found sufficient for sailing fleets of enormous magnitude, would be surely sufficient for the free manœuvring of the more moderately sized fleets propelled by steam, that I am trying to provide for.

This system of cutting up large fleets into smaller bodies so much more easily manœuvred, I consider to be of essential importance, especially with respect to the facilities it affords for rallying or detaching, and for keeping the ships together at night. To understand the arrangement, the division into smaller fleets must be considered quite independently of the regular fleet organization, which is applied in its full extent to each; they would be called the van, centre, and rear, or the van and rear fleets, and under their own commanding officers could each of course be worked independently. When, however, it was desired to manœuvre as one fleet, the small sub-divisions, into which, according to the fleet organization, each fleet is divided, must be clubbed together by twos or threes, according to the number of fleets, so as to form six large ones in all, and the whole can then be manœuvred as one, until again required to work independently.

At present one column, two and three columns, with no means of passing from one to the other, a couple of signals proposing to form four and nine columns never used, because the necessary directions are not given, are all the formations in line ahead. Then we have a single line abreast, a single line of bearing, and the double lines of bearing, and, as far as my memory goes, that is all. Many people, eager for simplicity, and thinking only of convenient formations for cruising in, will say that that is quite enough, but I will endeavour to show, that if only to avoid great unnecessary loss of time in manœuvring, there must be a great many more: there was a great want of freedom, also, in the manner of getting into or out of these formations, few as they were.

Suppose now a fleet in two lines ahead, which for some sudden reason, perhaps no room to wheel, or change the course on a pivot,

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alters course together eight points to one side or the other, they are now in two lines abreast, and how are they, keeping their present course, to get back into their two lines ahead? At present there is no recognized way, and the Admiral would have to invent some special contrivance suitable to the occasion; and this shows that two lines abreast should be one of the regular formations, as well as two lines ahead; and changes of formation should be capable of being made to and from it, although it might not be considered a desirable formation for cruizing in. There are numerous other occasions on which it would be equally convenient, and whatever may be said for two lines, may also be said for the three and six lines, into which the fleet can be sub-divided.

But it may not be necessary, or desirable, to change the course either precisely eight, or sixteen points, and any other course adopted simultaneously, will throw the fleet on oblique lines; now for some reason it is wished immediately to change the formation, but nothing can be done, because of this kind of formation, the single column only is recognized. It is therefore desirable for this among other reasons, that there should be certain means of manœuvring when the two, three, or six columns, chanced to be thrown on oblique lines, or that they also should be "recognized formations."

We have thus arrived already at twelve formations, but there is no occasion for counting up to so high a number; by calling the single column the first formation, the two divisions the second formation, the three squadrons the third formation, and the six sub-divisions the fourth formation, and according to the coincidence or otherwise between the course steered and the line of the columns, classing them as in "line ahead," in "line abreast," or on an "oblique line of bearing," we can stop at four formations.

There is yet one other essential to be provided for, a point of which very little notice is taken in the present arrangement; it is to provide for the principle, that it is as likely to desire to form the lines abreast with the numerical succession counting from one side as the other, and the formations in line ahead, or on oblique lines, with the columns ranged in order from the "left front," as from the "right front:" to provide for this, we must have two orders of each formation; with the sub-divisions placed in succession from the "right front," the formation is in "direct order," and if from the "left front" it is in "reverse order."

The only other formation that I think needs to be provided for, is that at present called "on double lines of bearing," but which I should call after Sir W. Martin, the "angular formation;" it consists of the whole or any indicated portion of the fleet, divided at or near its centre ship, from which the divided parts called the Van and Rear wings, can be placed on any desired bearings forming an angle with each other; it may be formed in "direct, or reverse order."

These are all the formations that it seems to me to be necessary to provide for. Such a number as six columns are quite as many as it would be desirable to manœuvre together, but if more are required, I would provide for it as I have already explained, by dividing the fleet into two or three smaller fleets, which by being worked separately will

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allow for an almost unlimited number of columns, and will be altogether in my opinion, a more desirable manner of manœuvring large fleets.

I wish here again to disclaim altogether any intention of suggesting formations for taking a fleet into action; so many people confound the mere manœuvring of a fleet, intended to be provided for in a system of evolutions, with the special arrangements that would be required for action, that such a disclaimer is necessary. One of the most common objections one hears, is, that in the smoke and excitement of action, every Captain would have to act as his judgment directed, and all these signals would be of no use; forgetting that the manœuvres before a battle are often more influential as to its result than the actual chances of the fight. With a large number of ships at the distance, that from their size, they will require to be kept apart, there will still be constant opportunities for making a concentrated attack on some one portion of an enemy's fleet before the other can come up, short it may be, but with the modern improvements at which we are arriving, not perhaps proportionably sweet. It may be an object to place your fleet before the attack, between the enemy and his port, or to get at a convoy he is protecting; to do these things, and at the same time to be prepared for any counter-strokes, there must not only be almost unlimited powers of manœuvring, but any means that may have been provided, will require to have been previously well studied and practised; while, independently of all this, an Admiral will still have as heretofore, to make his own plans for the actual conflict.

It will be natural to suppose, considering their variety, that any such selected plan of attack might be based on one of the formations provided, at any rate that it could be more easily delivered from some particular one, than from the others, and therefore a thoroughly free system of manœuvring such as I here recommend, will be useful up to the latest moment. With this end in view, while preparing the system of changes of formation, I am about to describe, it has been my endeavour, while making the evolutions take up the shortest possible space of time, to give as much variety as possible, and it may be that in doing so, particularly in such cases as changing the direction of the line of bearing and others analogous to it, a certain amount of precision and regularity has been sacrificed, at all events to the appearance of the evolution. I will, however, at once confess that I do not attach such very great importance to mere regularity; a line of bearing, or a line abreast, is equally efficient as far as the bow fire is concerned, although the ships may not be by any means in an exact line, and as that is in all probability what is required, I would not delay getting it for a single second more than is absolutely necessary. In contrasting for instance the plan I should adopt, which in substance is that which already exists in our Navy, for changing from a line ahead to a four-point bearing, with that proposed in the French book and in other quarters, I should say, that while they sacrifice time to regularity, we, though not on account of any departure from these suggestions, sacrifice regularity to time. At the same time I do not admit that we sacrifice any essential regularity, any more than that they, by a plain sacrifice of time, have really gained it.

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Again, by insisting that each ship should always turn on a certain sized circle, you evidently suppose that every ship is in her exact position. But from what I have seen of manœuvring ships, whose officers were doing their utmost to keep them in their station, and where, the evolutions being only performed for exercise, plenty of time was allowed, I am led to have great doubts as to any great precision being arrived at when a fleet is being hurriedly manœuvred, and with lines irregularly formed; every advantage should be taken of any turns, simultaneous or otherwise, that may be demanded, in order to rectify their positions.

To return now to the means provided for making a change from one formation to another. The four general formations in the two classes of line ahead and line abreast, are made capable of being changed from any one to any other, involving in all, one hundred and twelve changes, and these are all provided for in eight signals. With regard to the third class, or the formations on an oblique line of bearing, I have found it impracticable to do more than make them interchangeable on similar bearings, but by wheeling them on a pivot, they can be changed into the other classes of the same formation.

As to the angular formations, they can be formed in either order, from single columns, and changed back into single columns of any class of formation.

It being so absolutely essential to provide that each change of formation may be made with reference to the new formation being desired in "direct or reverse order," and also so desirable to provide for manœuvring without reference to the relative positions of particular ships, it is arranged, that when once formed in a formation, the evolutionary names or numbers of its various component parts shall be wholly positional, original names or numbers when alluded to, having the word "prescribed" affixed to them. Any ship chancing to be leading is therefore called the "leader," the sub-division that comes first, the "first sub-division," while the divisions and squadrons will take their names in accordance with the numbers of the sub-divisions. Although the sub-divisions are thus made entirely interchangeable, it will be seen that as to the individual ships of which they are composed, their order is not disturbed, and that they will always be found placed with their "prescribed leaders" towards the same extremity of the column or formation, and this therefore fixes for us an extremity of each column, which I call the "leader's end," from which extremity, the compass bearing of the line of bearing called the "column bearing," is always taken.

I will now proceed to describe the evolutions by which it is proposed to effect these changes of formation, and otherwise manœuvre the fleet: they may be classed as follows:—

1st. To change the formation, by a flank movement.

2nd. To change the class of a formation, by turning it on a pivot.

3rd. To change the course of any formation, by a flank movement.

4th. To change the course of any formation, by wheeling it on a pivot.

5th. To exchange the positions of any two columns.

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6th. To invert the order of the ships of any column, and

7th. To increase or decrease the distances between adjacent columns or ships.

To begin with the first in order, or "changing the formation by a flank movement." What is here called "a flank movement," is a class of evolution first brought prominently forward in connection with Naval Manœuvring, in the French book of Naval Tactics translated by Captain Phillimore; being mathematically the quickest, it will also be found practically the most advantageous method of making the changes of formation in which it is employed, having this additional great inducement to its use, viz., that of not requiring the speeds of the ships to be interfered with. Its principle is, that the rear ships, or columns, shall be the standard by which the formation is to be completed, instead of the leading ones, as formerly; and on account of its obvious advantages, I have employed it in all the one hundred and twelve interchanges between the formations in line ahead and line abreast. Diagrams 3 and 4 (Plate xlv) will show the style of movement, and on comparing it with the same evolution, as performed by the old method, the gain is at once apparent. In the given example, where the one column in line ahead is being changed into two, it will be seen that without any change in the speed, or any difficulty in deciding on the change of course, the new formation is completed, as soon as the rear division can fetch up on a level with the van, or when it has steamed a distance equal to the length of the column; while by the old method, even supposing the speed of the van division to be instantaneously stopped and resumed, it had to steam over a space equal to the hypothenuse of a right-angled triangle, whose other sides each equalled the length of the column; but, of course, the speed is neither instantaneously stopped, nor is it entirely stopped at all. Its resumption is also a matter of time, the whole of which is so much additional dead loss, as compared with the former method.

Having thus briefly described what I mean by changing the formation by a flank movement, it only remains to repeat that it is the system selected, by which all changes of formation that can possibly be based on it are performed, and then to proceed to the consideration of the second class of movement on the list, described as "changing the class of a formation, by turning it on a pivot."

I have already described how the four general formations, that is, the one, two, three, and six columns, have their two "orders" and three "classes" respectively. Taking, for example, the second formation, or two columns, we can have them either in "line ahead" or "line abreast," or on an "oblique line of bearing;" and it is easy to conceive that, taking one angle as a pivot, and keeping to the same course, the formation, if turned round, will pass through the different classes in succession. The detailed plan for doing this is merely an adaptation and extension of the old method of forming a "line abreast" from a "line ahead," but its principal use is now intended to be in making small changes in the line of bearing when it is not desirable to change the course. It is performed by one ship, selected according to her position, and the side to which the change is to be made, acting as a

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pivot for the rest, by reducing her speed according to the change of bearing, while keeping a steady course, and each other ship under certain restrictions, circling round her "next towards the pivot" to her new bearing. Treated in this simple manner, this evolution is an exceedingly useful one. True it is, that if time is an object, it should only be employed for small changes of the bearing, leaving the larger ones to be done on the flanking system; but it gives a simple and easy means of doing that which, in the case of hurried evolutions, would constantly require to be done, viz., the making of small changes in the line of bearing of the columns.

We will now pass on to the third description of evolution, or "the "changing of the course of any formation by means of a flank move- "ment." In common with all the other flank movements, these are taken in substance from the French tactic book before mentioned, and the system is applied to all formations in line ahead or line abreast. They are intended to be employed when the course is to be changed more than four or five points, and are invaluable above these limits wherever it is desired to preserve the formation in its present succession; a great gain in time being attained, as compared with the old system.

Supposing a fleet to be formed in two or more columns, in line ahead or abreast, there are two methods of changing the course up to about four points. The first and most common is to wheel the formation on a pivot, or as it was called when, as formerly, it was only employed for lines ahead, to "alter the course in succession." The second, and I think in no way the inferior plan, though involving two signals, is to change the course together to the new course, throwing the formation on to oblique lines, and then, by the evolution just described for rectifying the line of bearing, wheeling it up on one of its angles as a pivot to its original class of formation. This latter method would also be the most advantageous when the change of course was more than twelve points, and an inversion of the order of the ships in line ahead, or of the columns in line abreast, was immaterial; but between about four and twelve points, the superior plan beyond all comparison, is that by the flank movement which I will now describe. Let us take a squadron in two columns in line ahead, steering north, and the course to be changed to south-east, by a flank movement to the left of the new course; the leader of the starboard column at once turns to a direction eight points to the left of the new course, followed by the ships of his column, while the leader of the port column leads his ships, in the first instance, on a line eight points to starboard of his present course, arranging his speed so as to strike in astern of the last ship of the starboard column. This is the moment at which the signal should be made for the assumption by the leaders of the new course itself "south-east;" but in case of delay, the leader of the port column must turn after the starboard column, and follow it. The two leaders may, therefore, be steering the new course in their proper relative positions, in the time from the commencement of the evolution, that it would take to steam the length of the column, and the whole of their respective columns may be formed in their wakes in the same time over again; and taking into consideration the

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time lost in reducing and regaining the speed alone by any other method, it is the shortest possible evolution by which the change can be effected.

The fourth subject in order is that already now partly discussed—"changing the course of any formation, by wheeling it on a pivot." As applied to formations in line ahead, this evolution is called "altering "course in succession," and I shall here only proceed to describe it, as applied to those in line abreast. In the first place, let us take the case of the single column, or the "first formation." The extreme ship on the side to which the course is to be altered, turns to the new course, the other ships, at the same time turning towards her half the angle only that she has herself turned, each then keeping its distance from the next ship on the pivot side, steams up into the line abreast as fast as is consistent with not passing before the beam of such next ship, or beyond the "line produced" between her and the pivot. The speed of the ship acting as the pivot, must, of course, be reduced, in proportion to the extent of the change of course. This method as to the single column might be used with safety to the full extent of sixteen points; but above four or five, the flank movement system is so much to be preferred, that I should limit its use to four points at a time, thereby allowing it to be applied to the second, third, or fourth formations in line abreast, as well, in the following manner:—While the leading column is wheeling as described above, the other columns, with their original distance from the column ahead carefully preserved by their pivots, are forming up on a bearing from their pivot ships corresponding to the line of bearing of the new line abreast, so that when the first column having wheeled, the whole proceed at their former speed, each succeeding column will have merely to turn together to the new course as they arrive in the altered wake of their preceding column.

We now come to "exchanging the positions of any two adjacent "columns," and "inverting the order of the ships of any column." These are very old and simple evolutions, and beyond saying that safe means are provided for performing either, whether the columns are in line ahead, or line abreast, it will not be worth while here to discuss them.

Lastly, we come to the important point of "increasing or decreasing, "with the utmost rapidity, the distances between adjacent columns or "ships." As far as the columns themselves are concerned, it is necessary to provide, that unless a particular column is denoted, the extension or compression is to take place with respect to the centre of the formation; whether that position is filled by a column or not, except in the case when the formation chances to be on oblique lines, when an extension must be made from the column most astern, and the compression towards the column, furthest ahead. In the formations in line ahead, the moving columns are to turn out or in four points, and with oblique lines, in a proportion of one point less than four, to each two points of obliquity; in lines abreast, the moving columns attain their object, by regulating their speed alone.

The extension or closing of the distances between adjacent ships, to be rapidly performed, will demand considerable care and skill, espe-

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cially in the case of formations in line ahead, which we will now consider. It is simply enough described. Any ship may be selected by which the column is to be regulated, and such ship is to continue exactly at her former speed; the other ships are to increase or decrease their speed together, or as nearly so as is consistent with waiting for the change of the speed signal of their next ship, towards which they are to close, or extend, by which they will not only be aware that such ship has commenced her evolution, but will also be informed of the extent of her alteration of speed by which to regulate their own. Easy as this is to describe, there is no doubt, that to close a large number of heavy ships on one point with precision and rapidity, is one of the most delicate manœuvres a fleet can be called on to perform. It will perhaps be found an easier evolution, when applied to columns on a line of bearing, other than a line ahead, when it should be performed as follows:—If closing the order, the most advanced ship of the formation would, as a matter of course, be that on which the column should be closed, and this ship should continue her course, the rest of the ships, at their former speed, should turn towards her an angle, equal to half the obliquity of the line of bearing, the regulator reducing her speed, so as to keep them during the movement on their former bearing; then each ship in succession, as she arrives at the proper distance, resumes her course and reduces her speed. If extending the order, the rearmost ship must be the regulator, and should the line of bearing be a line abreast, any ship may be selected.

Having thus explained briefly, though not enough so, I fear, for the patience of my hearers, the descriptions of evolution that seem to be required, it will be necessary to notice the arrangements by which it is proposed to render their actual execution sufficiently precise. At present it is always rather a matter of doubt and opinion, among other things, as to by what ship the formation is to be regulated, supposing the Admiral's ship to be stationed in the centre of a column, instead of at its extremity. A similar case of difficulty arises, when a column has to be conducted to a certain position with reference to another, and the senior Officer happens not to be at the head or flank of his column. There are many other cases of difficulty of this sort, of greater or less importance, but all of which interfere prejudicially in a corresponding degree with the free manœuvring of the fleet. I have therefore considered it absolutely necessary that some ship in the formation denoted solely by her position, should act as "regulator" for the whole fleet, and should the fleet be in more than one column, that the ship in a corresponding position in each other column, should be the one by which that column should be regulated; I call these ships respectively the "fleet and column regulators." In the formations in line ahead, and line abreast, it is considered advisable to be able to regulate the fleet from either side at will, and the "fleet regulator," therefore, in these formations, is the ship at the extreme "right front," or that at the extreme "left front," in accordance with whether the fleet is being manœuvred in direct or in reverse order. By this arrangement, during the flank movements, by which all changes among these classes of formation are effected, it becomes possible to regulate the fleet by its

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"fleet and common regulators," during the actual progress of the movement; a point of essential importance. With regard to the second difficulty mooted, that is, the impossibility of the senior officer of a column, being able to give the precise courses required to his column, say to conduct it in line of bearing astern of another, unless in a certain position, it is provided that this shall be done by the "column regulators," under the correction of the senior Officer.

I will now say a few words as to the facilities afforded for the keeping in their station of the individual ships. Take the case of a ship in a longish line ahead, which by accident, or carelessness, has dropped, or shot ahead a little out of her station. Now, as at present each ship keeps her station solely with reference to her next ahead, this error on the part of the ship we are noticing, is felt by every ship astern of her, occasioning a great commotion, and a large extra expenditure of coal, the general result being that you rarely have the rear ships in anything like their stations. To remedy this, I should recommend that the next ahead should only be retained as a guide, so long as she was in her own station, which is to be ascertained by observing the distance in addition, of any of the near ships ahead of her that can be seen, so that a ship, whose steam, for instance, has accidentally got low, will be able to drop and again regain her station, the proper precautions being taken, without throwing the whole line out, as at present. In the case of a ship being actually unable to keep up, the fact of her making it known to the Admiral, and sheering out of the line, which she should immediately do, would be the signal, unless the speed of the fleet was at once reduced, for her place to be filled up by the ships concerned, without further directions.

It is of course impossible here to give more than a bare outline of the provisions on this and other subjects; but to those who have given any previous attention to the matter, they will, I hope, be sufficiently intelligible; and I will now, before concluding, make a few remarks on the general working of the system proposed, for instance as to what plan, if any, should be followed in originally placing the ships in the sub-divisions. It would, I think, be desirable that ships of a particular class should be kept together, but their particular arrangement must depend on circumstances; by keeping ships intended for ramming, or other especial purposes, in sub-divisions by themselves, much trouble and confusion might be expected to be avoided. Perhaps in default of other more important considerations, such as speed, the ships might be placed in their respective sub-divisions with reference to their turning powers, the fastest turners at one end, and the next fastest in succession; but this is, I think, a matter of small importance. A turning circle, of the smallest radius that all can turn on, should certainly be fixed on, and made obligatory on the "fleet regulator," while all others should go as near it as is consistent with, at the same time rectifying any discrepancies in, the position of their ships.

As to the formation in which it will be most advisable to keep fleets while cruising, I cannot help thinking that too little attention has been paid to the advantages offered by the line of bearing, or line abreast, at all events for day work. The difficult work of keeping a ship in

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her station, it will be allowed by all, is the management of the speed. What has made this appear so difficult is, that when in line ahead—the order in which our ships are always kept—it is impossible, without very careful watching with the sextant, to detect those small beginnings in the variation of the distance, which it is so necessary to check. The difficulty is also increased, by the relative positions of the two ships, for as everybody knows, when looking at another ship right ahead, it is very rarely that something or other does not intervene, and partially obstruct the view. Now in a line abreast, or line of bearing, the management of the speed at once becomes the simplest part of the affair, and the chief difficulty is thrown on the management of the helm. With the form of compass card which I have proposed for use, by which all mental application of the error occasioned by local deviation is avoided, combined with common care in the matter of comparing the compasses of the fleet by simultaneous azimuths, or otherwise, this difficulty would I think be found to be reduced to a minimum.

Most people's experience of an oblique line of bearing, is unduly influenced by the difficulty they have found in keeping station, after wearing together in a squadron under sail, when it was blowing too hard to tack. No comparison, however, should rightly be made between this and the same formation in moderate weather, with ships under steam. By keeping the ships in a line abreast, or on an oblique line, all unnecessary risk would be avoided in case of a fall overboard; much coal would be saved in keeping station; the Admiral would see much more of his ships, and would be sure of having them close up in their places. At night the bearing might be diminished to three or two points from the fore and aft line, and the firing of a gun, or other signal, could cause the simultaneous sheer into the wake of the next ahead, requisite to avoid the chance of a collision with a passing ship.

When speaking of oblique lines, it would not be right to omit all notice of the "double lines of bearing," or the "angular formation." As these formations have hitherto been arranged and manœuvred, they have not I confess been particular favourites of mine. By the laws of their formation the order of the ships was so broken up, that no manœuvring was possible, until by an awkward process, impracticable if pressed by an enemy, you had got out of it as you got in; and now, although after a great deal of trouble we have succeeded in providing the means of manœuvring them, I do not feel inclined to say much more in their favour. Even for a retreat I see no great advantage; a pressing enemy would of course cluster on one side, and so render the other useless; and while it certainly keeps the ships concentrated, and so renders it more difficult to cut a part off, it renders them proportionably helpless, in case of an attack by rams.

Now as to the rams, the arm of naval warfare to which I attach the chief importance. In my opinion, the aim of all manœuvring, and preliminary practice with the guns, should be to get a fair opportunity for letting slip the rams. It may be very easy to prove how difficult it is for one ship to strike another, prepared for, and trying to avoid the blow, and in the case of single ships fighting on the open sea, I fully admit it; but with two squadrons bent on fighting, the opportunity is

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certain to be given by one or the other, and victory will rest with that which best knows how to take advantage of the chance afforded it. An enemy may be caught embayed, rocks and shoals may prevent his free manœuvring, and then for the rams. Never mind their guns and armour, but have them low, unsinkable, quick turners, and of great speed. Keep them in the background until wanted, and depend upon it they will be found the most suitable engine for the work required.

I have now I think, touched on most of the important points connected with Naval Evolutions. An organization has been provided which will always preserve the fleet, or what may remain of it, in a state to be manœuvred so long as the ships can be collected together, admitting as it does of any extent of expansion or contraction. The means of changing from one formation to another have been carried to their fullest extent, while the mode provided for manœuvring in every possible way, and in the quickest manner, has been briefly explained. It will I am afraid appear that I am speaking in a very egotistical manner; but I will here repeat that I lay no claim to any special acquaintance with the subject, over those who may have given any attention to it; while the very system on which the whole of my observations are based, is that, I before mentioned as having been submitted to the Admiralty in 1863 by Admiral Sir William Martin. Any one however who has tried his hand at a paper of this description will, I feel sure, understand the difficulty there is, in assigning to each originator of a proposed improvement, his proper credit in the actual course of the description. The subject is a very old one, and most of the original proposers are to me unknown. But it will perhaps be considered sufficient to avow that with the work of Sir William Martin for a basis, I have taken the fullest advantage of all the previous writings on the matter that I could get at, as well as of the hints kindly furnished me by those officers of the Mediterranean Fleet, who were associated with me in practising the evolutions.

While thus admitting the very large share Sir William Martin had in the proposed system, I must fully exonerate him from all responsibility as to any extraneous views or opinions that I may have advanced in the course of this paper, and for which I must crave your kind indulgence.

The system thus worked out, has been so repeatedly under discussion, and as to its principal parts, so often put to the test, that perhaps a certain amount of confidence when speaking of it, may be excused. On public grounds it is certainly necessary to speak strongly, and I only wish that I could here place the subject in so strong a light, that more of my brother officers might be induced to open their eyes to its importance.

I am quite aware—and herein lies the great difficulty in pressing the matter forward—that with the present system, or at all events the system in force up to the spring of this year, a fleet may be very easily and safely cruised about. It may make a very fine show, and there may be plenty of evolutions, that with a little selection, it can well perform; but admitting all this, I am still afraid that it would be at the most imminent risk that any attempt would be made to put them to

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the test in the presence of an enemy. Then, instead of being able to pick the evolutions which you know you can do, and which everybody knows, you will find a terrible pressure put upon you, and most of all for time; your rams are at the wrong end of your line, and you have no time to change them; or your ships are too extended, and you have no time to close them. At last, when hurriedly forced to adopt certain movements, you will find that these are the very evolutions that previously you had so studiously avoided. Somehow, the ships all seem to be going as if they did not know by which to guide themselves; each column slackens its speed, so as to regulate itself by another. Then you find, that smart as your signalmen are, the signals cannot be made quick enough; eventually the poop gets enveloped in flags, and the men look nearly as puzzled as you do. Then the ship leading seems to have forgotten to apply the point-and-a-half deviation that belongs to her compasses, or has done it the wrong way by mistake. You try more signals, but the end has come, time forbids further changes; in despair you whip up a final signal for close action, clap on full steam, and trust to luck and Providence.

Now, this may be a strong picture, but I have seen as curious scenes, without the extraordinary pressure of an enemy's fleet. I do not mean to assert, that such as I have described, is certain to be the result of an attempt to manœuvre an English fleet, but unless changes are made, it may be; and I do not mean to assert that the opposing fleet is always to be well and skilfully manœuvred; but again, it may be. Now, if by bad luck these two may be's should come together, I do not like to anticipate what the result would be. Judging, indeed, from the apathy one generally sees displayed on the subject, the consequences should not be serious, and I try to imagine that we should soon build more ships, and have another try for it. It is as well, however, if the opinions I express are found to be shared by those in whose experience, confidence should, if anywhere, be placed; that people in general should have some idea of what they have to expect.

A fleet, skilfully and rapidly manœuvred, would have as great an advantage over another in a less advanced state of preparation, as the superior organisation of the Prussian army gave them in their late war with Austria. A naval engagement, now-a-days, will not probably be a very long business; half an hour might see one fleet or the other pretty nearly demolished, and it would be suicidal that our fleets should be sent to their work wanting that confidence and promptitude which could so easily be acquired by practice. Eighteen or twenty gunboats, manned from the Channel fleet, and collected for a couple of months yearly at Portland, would, at a most trifling expense, soon effect an utter revolution in people's ideas generally on the subject of fleet manœuvring. The gunboats, I believe, the officers and men, certainly, are all ready, and the comparatively small expense of the coal required, should on no account be grudged.

How would armies be manœuvred, if officers and men were never instructed in anything besides the manual and platoon exercise, with an occasional march to and from their barracks? That is about the counterpart of the experience the Navy is permitted to obtain. What

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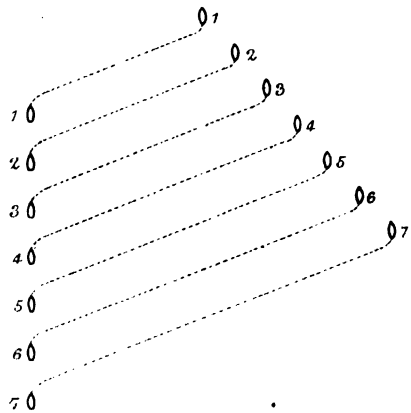
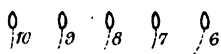


Comparison of the methods for forming a line
Proposed New System.



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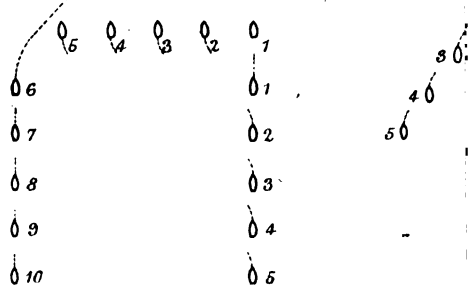

Second Class of Evo

Changing the class of a formation by turni

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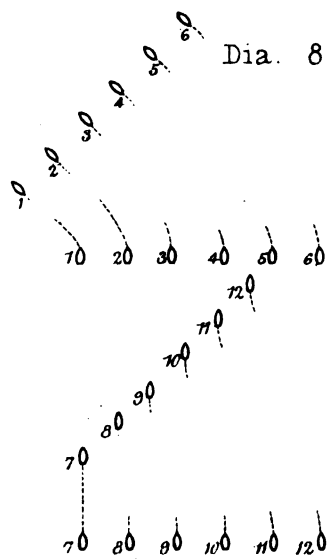
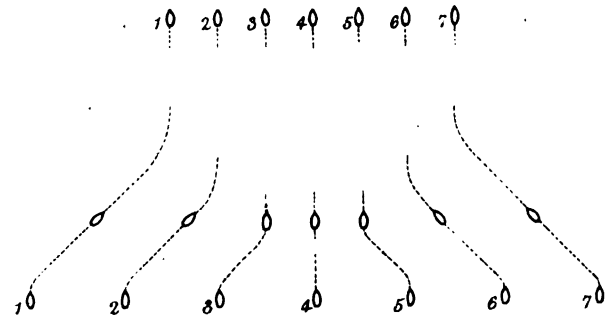
Dia. 8.



Fourth Class of Evolution.
Changing course by wheeling

Dia. 9.



Seventh Class of Evolution
Decreasing distances between adjacent Ships

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Admiral ever has an opportunity of taking out twenty or thirty sail, and trying his hand at manœuvring them? I do not mean at jogging along at five or six knots, with the ships at great distances apart, and taking all the forenoon to change from two to three columns, or form a line abreast, but really to manœuvre as if going into action, with his ships at a high rate of speed.

At present, I am afraid, it must be confessed that we know very little about the matter; but it is to be hoped that a brighter day is dawning, and that our future leaders will yet be permitted to pick up their experience before the time of trial comes. My time, and the object I had in view, being now alike disposed of, I will conclude by thanking, most sincerely, the Chairman, and my hearers generally, for their kind attention.

The CHAIRMAN: We shall be glad to hear any observations that gentlemen may wish to make.

Vice-Admiral E. P. HALSTED: I think the main observation which any of us can well make is, how very much we are obliged for such a paper, and how very disqualified the greater portion of us are for really going into the true merits which belong to it. There is not a single shadow of doubt that none of us have any possible means, not even to the extent of gunboats, not even to the extent of ship's boats, of apprehending practically the manœuvring of a fleet. Therefore, truly we have to acknowledge with gratitude the attention which has been given to the subject, and the ability with which that has been done. As for discussing it, I am utterly incapable of doing it myself. I beg to offer my full meed of grateful thanks for what has been put before us. The paper contains evidence of having been prepared with great ability, as well as a great practical apprehension of the whole subject. Beyond that, at this present moment, I am quite prepared to sit down.

Captain W. HOUSTON STEWART, R.N., C.B.: I should like to make one or two remarks. While most fully agreeing with the observations of Admiral Halsted as to the little opportunity that Naval Officers have, of learning how to manœuvre their ships, I very much regret that there is not a much larger attendance of Naval Officers; and I still more regret that there are none of our directors or rulers here—those who might give the Officers of the present day the means of learning what they will one day find the want of, as Captain Pellew has put it in much abler and clearer language than I can do, at the conclusion of his most able lecture. I think it is a most valuable lecture, because Captain Pellew is thoroughly master of the subject. Being ignorant of it myself, I had the advantage of being a pupil of his for some time, when he was flag lieutenant under Admiral Sir William Martin. For two years he gave his entire attention to this system; studied the various systems of naval tactics of every nation in the world; and I believe that every system of manœuvres in these naval tactics was tried by him, either with dummies, or with pieces of wood representing boats. The system of manœuvres now before us is formed upon improvements made upon other systems of tactics. Having occupied the position which Captain Pellew did of flag lieutenant, he has had the opportunity of observing the great necessity there is for a system of tactics. Those outside the Navy, if there are any such present, would hardly believe, how helpless our ships are in the way of manœuvring. No one is to blame for it, because we really never have the opportunity. Captain Pellew says that he believes there is a brighter day dawning for us. I hope there is. I do hope that the subject will be brought before the British public, for they seem to be the masters at the present moment. Our Navy is without a system of tactics. I can only say, with reference to this system, that I have seen a party of twenty-four Officers, midshipmen and lieutenants, who had never seen a single manœuvre, assemble in a cabin, and in one hour the manœuvres were performed without the slightest mistake. That shows how simple the system is, and how easily it may be acquired.

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Admiral RYDER: There are two or three remarks I should like to make; but I would much rather hear Captain Colomb speak first.

Commander COLOMB, R.N.: Admiral Ryder has been good enough to refer to me as being possibly capable of discussing the very able paper that we have heard read. Having a little knowledge of the difficulties that Captain Pellew spoke of in preparing a paper of this sort, it strikes me that Captain Pellew has shown a very great grasp of the subject, in the way in which he has addressed himself to it. I say that, because I know how difficult it is to draw up a paper of this kind. I think the service sustained a loss in the fact of Captain Pellew's health having broken down when the Admiralty awoke to the necessity for having a complete system of tactics before them. But Captain Pellew worked with me long enough to impress me very much with his practical knowledge of the subject; and I must say that I made the fullest use of it in what was done under the direction of the Admiralty. Sir William Martin's book was the only complete system of tactics which was before us when we had to draw up the new plan. Not only was it the only complete system, but it was the only system which was based upon a principle that could be carried out throughout. I suppose I break no confidence in a professional meeting in saying that by far the greater part—I may say nearly the whole—of the principle of that book has been adopted by the Committee which sat to investigate my work. I based the system of tactics almost entirely upon that book, making alterations in language here and there, and the Committee which sat to investigate the system adopted it almost throughout. I hope it will form a basis. Of course, it can hardly be said to be complete, because until it has really been practised by the fleet, it is impossible to say that any system can be complete. But I hope when the system has been practised, that it will be no longer possible to say that the Navy is without a system of tactics. Captain Pellew, I think, spoke very justly of a remark that we constantly hear: "Oh, fleet manœuvres and signals are not very important, because "the Admiral must arrange his plans beforehand." It has always struck me that it would be easy enough for the Admiral to arrange his plans completely beforehand could he know in what position he was going to meet the enemy's fleet. As it is impossible for him to tell this, I look upon it that the Admiral, who best understands his work at the present day, will trust more to his signals, and more to his capacity for manœuvring his fleet on the spur of the moment, than he will to any detailed plans before made; because we all know that any detailed plan of attack may be utterly thrown to the winds; if the fleet he means to attack does not happen to meet his attack in the way he expects it. When I say I believe the Admiral will trust to his signals on the spur of the moment, I do not mean that he will do that if the action has commenced. I think Captain Pellew spoke very justly in saying that the most important manœuvres take place before the commencement of the action. It is the mode in which you deliver your attack which gives you victory, and loses it for you; and that, I believe, is arranged before the action commences. I believe that the period of time during which fleets will now be under fire will be very short. We saw in the action off Lissa, as I remarked the other night, one of the changes coming over naval battles; that is, the fleets are more likely to pass through one another, engaging while they pass, to separate again, and reform for the attack. Therefore, if that is the true idea, the importance of evolutionary signals based upon a proper system, and the importance of securing that your fleet shall move from formation to formation in the quickest way, cannot be exaggerated. Captain Pellew spoke rather in disparagement of the necessity for ships turning upon the same circles. The necessity for such a thing was first pointed out by the Russian Admiral Boutakoff. I had the honour to carry out in the Channel squadron some experiments to test how far the necessity for similar circles was practically necessary—reversing the line, the fleet being in line ahead—altering the course 16 points, that is, to the opposite course, to the right or left—and we found that invariably, unless steps were taken to make ships turn on the same circle, the formation was utterly destroyed—not partially destroyed, but utterly destroyed; that there was no longer anything like a line. But when ships were taught to turn upon the circle of the ship which was least under steering power, that then the time lost was insignificant, but that the fleet, on arriving at the new course, 16 points from the old one, came

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immediately into their places, without either difficulty or trouble. The difficulties that a modern fleet has to contend with in manœuvring in the face of the enemy are, that the rear may be the front, or the right the left, at any moment; and it is absolutely necessary to have your system of tactics arranged on such a plan that it will enable your rear to act as your van, the van as your rear, your right as your left, and *vice versâ*. The plan that has been adopted for the present is to establish a set of local terms. It is merely carrying out to a further extent what Admiral Martin has noted in his book in three or four places, and what Captain Pellew has spoken of again to-night—having a system of local terms referring to parts of the fleet; and in the evolutionary signals these local terms only are used. The "starboard column," for instance, will be the starboard column at the time the signal is made; the "port column" will be the port column at the time the signal is made; the "leading column" will be the leading column at the time, and the "rear column" the same. If the fleet alters its position the columns alter their names in in the same way. That is a plan that, as far as I can judge, will tend to simplicity in the arrangement. A very important matter also brought before us to-night is, how much better it is to manœuvre a fleet by the helm only than by the speed. If the speed of a fleet be uniform, as it ought to be, and the ships are accustomed to turn in the same circles, then a movement of the helm has a similar effect upon every ship; but if you come to alter the speed, you immediately alter the size of the circles in which the ships turn. Besides that, the helm is under the control of the Officer of the watch; the speed is only partially so; therefore, if you can manœuvre your fleets, and I think you can, by the use of the helm, you gain in simplicity. The question upon which ship fleets are to form is also a very important one, and I fully agree with most of what Captain Pellew has said upon that subject. It also shows us a point which I have before remarked upon—that is the difficulty of making the Admiral part of the formation. If you make the Admiral part of the formation, whatever the orders may be, they will insist upon making him, wherever he may be in the line, the pivot; whereas it constantly happens that the Admiral is not the pivot, and ought not to be the pivot. The consequence is, that ships are thrown out of their position by the double idea of the proper pivot, thinking at the same time that the Admiral is the pivot. I recollect once the Channel squadron being detained half an hour, because we had got the Admiral in rear of the line. We wanted the leader to go on, and we were fully half an hour making signals to her, which she could not understand, before we could go on. Such an instance happening in the face of an enemy might be fatal. As regards the oblique line of bearing, I agree with Captain Pellew that it is, or ought to be, a good cruising formation; but it is a formation very difficult to maintain accurately, and I think Captain Pellew agrees in that—it is not a good formation in action; it is too difficult to maintain accurately. But as a cruising formation, where it need not be very accurately kept, I think it is a very good one. As regards the angular formation, I agree with every point that Captain Pellew has stated throughout. Nearly the last point he adverted to was the question of rams. I must say I am very glad indeed to get a little support in that direction, because when I read my paper here the other night there were no remarks made upon the subject, except adverse to the idea of the ram being the chief weapon. The more I think of it, the more I go into the matter, the more satisfied am I that the ram is and will be the chief weapon. I do not say actual running down will be. It may be that some arrangement of the torpedo, such as I have heard adverted to, on the stem of a ship, may be the weapon; or it may be a very sharp spur, which, just touching a ship, will be able to destroy her. But whatever it be, I believe, the power of your engine driving your ship will give you the weapon that will be the most employed. In saying that, I do not mean to say that the ram will do the most destructive work; but I believe it will become the governing weapon of fleets, and that fleets will have to fight more with reference to avoiding the stroke of a ram than getting their guns to bear. It has been adverted to over and over again what a difficult thing it is to hit a ship. Now, I have had sent to me within the last two or three days a paper by Captain Randolph on the "Rules of the Road." I want to quote two remarks from it to show how, if it is difficult to hit a ship, it must be equally difficult, in a Naval

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Officer's opinion, to keep out of the way of a ship, which, I presume, cuts the ground away from the first difficulty. He says, "How a ship is to keep out of the way of "another? This is exactly the difficulty for which we want a rule for the assistance "of people in charge of ships, especially the inexperienced, nervous, or suddenly "alarmed." Now, it has been said there is a natural impulse to move the helm somehow. I quote this merely to show that while Naval Officers persist in saying that it is a very difficult thing to run down a ship, they are at the same time asserting it is a very difficult thing to get out of a ship's way. I do not think Captain Pellew drew too strong a picture of the state of affairs at the conclusion of his lecture. I believe what he stated is literally and actually true. As regards the employment of the gun-boat squadron, it is one of those things which people have been recommending until they are tired of recommending; but I hope when we are all thoroughly tired, we shall at last see something of the gunboats.

Rear-Admiral A. P. RYDER: I will not detain you with more than a very few remarks. I have been looking forward to this Lecture with great interest, as Captain Pellew knows, and I am very glad to see Captain Colomb here. I know they are equally good authorities on the point, and that we should hear much that was interesting on the subject from both of them. There are one or two points I should like to allude to. One is the question of speed. In my own experience—but I believe some officers will differ from me as to whether it is a good practice to adopt—I found great assistance in maintaining a regular speed by always dictating to the engineer the *number of revolutions* he was to maintain. If you tell him, "Go on faster! go slower! slower still!" and so forth, you never arrive at any regularity. But if you tell him to go at 44 revolutions, for instance, he then knows what he has got to do. He is not content merely with opening or closing his throttle valve, but he is constantly ascertaining the speed of his engine, and, if his steam is high enough to enable him to follow your orders, he maintains the speed you dictate to him. This seems to me a wiser plan than to tell him to "go faster" or "slower," which I know is the common practice. I had the dial plate on deck and the dial plate in the engine room divided for revolutions, so that the order from the deck was constantly under the engineer's eye. Captain Pellew referred to the possibility of applying the deviation the wrong way, and of the ships being led away from the course. In the "Warrior" they adopted a practice which is always useful, and which would not lead to any error as long as ships were cruising in the same geographical position; that is, to have a compass with all the points altered for the deviation, so that they should be absolutely accurate. This is of great importance when fleets are cruising and no great likelihood of changing their geographical position, and I should think it would be advisable to have one compass-card so altered in each ship. It is evident that no error can possibly occur as long as the deviation does not alter. I think it would be a useful thing for an iron-clad fleet, if they had their compasses adjusted in that way, viz., one card permanently altered for each cruising ground; be it the Bay of Biscay or the Mediterranean, there would be no great difficulty in either place. Both Captain Pellew and Captain Colomb have alluded to the advantage that officers would have, if they had the opportunity afforded them of witnessing evolutions. I imagine all officers who anticipate or hope to serve in the fleet, and who are now on half-pay, would be willing and desirous, if they had the opportunity, of witnessing the new evolutions. Whether the Channel fleet, which is shortly to proceed to sea, is going to practice the evolutions which, I believe, have all been prepared, and are in print, I am not sufficiently in the secrets of the Admiralty to know. But I can tell any Naval Officers who are here present, and who might wish to witness those evolutions, the amount of success, or rather the non-success of an application I made to the Admiralty, to know whether they would allow some small vessel to accompany the fleet, with half-pay officers on board (who certainly are not likely to go to the Bay of Biscay with any expectation of comfort or pleasure.) The "Vivid," or any other vessel of her class, would answer the purpose. I hoped that they would allow such a vessel to accompany the fleet, and enable half-pay officers to witness the new evolutions, and learn, as far as they could learn on half-pay, what they could have no other opportunity of learning. The answer I received was, that their Lordships had no intention of sending any such vessel with the fleet.

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Lieutenant A. GILMORE, R.N.: I think there is no reason why the Admiral, at noon, should not telegraph to the rest of the fleet the deviation of the compass of his ship, each ship would then know what the deviation of the Admiral's ship was, and what course she was steering, and there would be no difficulty whatever in keeping the same course that she did. I would also remark, that in the present day when ships differ so much in speed, and in force as regards guns, and the disposition of guns, that the system of naval tactics is very difficult to bring to any issue. I fancy that rams will be kept as a reserve; that the ships of the line will go into the conflict, and the rams will be kept in reserve to go and ram the enemy that is engaged with their friend. As regards the regulation of the speed of the ship by the engines, all the ships should be regulated by the speed of the Admiral. There would be no difficulty whatever in the officer of the watch, or the captain of the ship, after half an hour, knowing the relative speed of the vessels, and sending word down to the engineer, "So many revolutions!" instead of "half power!" or "full power!" Then the ships would be regulated to the same speed, and the same amount of helm would influence each. As I said just now, it is most difficult at present to introduce any system of naval tactics from a line of battle, when ships all differ in speed and effect; one going 14 knots, another 12, another 8. There are no two vessels in the Navy built on the same principle, or calculated to effect the same purpose. One carries a 12-ton gun, another an 8-ton gun, another a 6, another a 4; no two are the same. We all know that the speed of a squadron or fleet is the speed of the smallest vessel. You must either go ahead, and leave her in the lurch, to be attacked and taken, or you must slacken the speed of your whole squadron to her speed. I think that fact is overlooked in all our naval constructions. In the last few years, Mr. Reed has tried to put undue steam-pressure into ships to drive them ahead. The effect must be that those vessels, after a very short time, will become overstrained and unseaworthy. Whereas, if vessels were built on one principle, and contented to attain a due rate of speed, naval evolutions would be much more simple, because things would be equal. At the same time, a few vessels might be attached to each fleet, as rams, to go in at high speed with powerful prows, when an enemy is in line attacking our fleet, and to ram our opponents. I think, when our Channel fleet, as at present, consists of about seven vessels, some of one speed, and some of another; some with one size of guns, and some with another, that Captain Pellew's system is all thrown away; and until a more uniform practice of building, &c., is introduced, he will never be able to see his system adopted.

Captain HEATH, R.N., C.B.: I am one of those who are rather afraid of too much tactics; and I suggested to Captain Pellew whether, by sub-dividing into four instead of into six, his object of avoiding the difficulty of turning over three columns into two, will not be equally attained, whilst my object of simplicity will also be attained. I agree with those who began the discussion, in saying that it is impossible really to discuss the important paper which Captain Pellew has put before us, for want of preparation on the subject. But I must say that I think the old signal book is quite competent to do a great deal that is wanted to be done—"Alter course together!" "Alter course in succession!" "Preserve a certain line of bearing! a compass line of bearing!" With respect to columns—"Preserve a certain compass line of bearing!" Those old signals will do a very great deal which you are now attempting to do, by more intricate rules. It must always be remembered that these rules are variable, and intended to be put in practice only in order of sailing; that in sight of an enemy, your first object is to form your order of battle. Once your order of battle is formed, you must never forget Nelson's rule, "No captain can do very wrong who puts his ship alongside his enemy."

Captain FREMANTLE, R.N.: I did not intend to say anything at all, but after what has fallen from the last gentleman, having had some experience in the manœuvring of fleets under the old system in the Channel fleet, I think it right to state what my experience is. Under the old system, with the old signal-book, it was extremely difficult to manœuvre fleets at all, especially under steam; and when we got the fleets into some particular formations, which were easiest and best understood, they would not be the formations which we should more particularly have required in case of action. I may specially mention that which Captain Pellew has referred to,

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namely, the angular formation. Certainly, when fleets are formed in two lines of bearing, it requires several formations to get them into their lines of battle, or lines of squadron sailing. Captain Colomb said something about signals with regard to columns. As far as I understand him, it would be simply a question of flags; the flags would not always refer to the same division; that is, the flags would be changed as the divisions changed. That is to say, if I may use an old illustration, the letter M would not always be the starboard division. I do not think anything could lead us into a greater mistake than that; because I found, in manœuvring fleets, it was a great advantage that letter M always meant the starboard division, namely, certain ships belonging to a special section of the fleet. That was the only safe guide you had.

Captain COLOMB: Perhaps I may be allowed to make one remark in answer to what has been said. We have employed two distinct modes of naming divisions, or squadrons. The squadron flags addressing them, always address that particular division, no matter what its particular position may be. But when the divisions are spoken of in the signal, then their local signification is given. So you have two distinct methods of speaking to the divisions; they are first, second, third, and they are also named the starboard division, the port division, and so on. I may also read the second paragraph from Captain Randolph's book, to which I called attention:—"The rule of giving way may be a very good rule for the open road, but it is no "guide at the moment of impending danger, if not an embarrassment. I can con- "ceive it highly probable, that if three people were on the bridge, one would advise "starboarding, another porting, and the third stopping." This is from an officer who has very gravely considered the subject, not with reference to rams, but with reference to getting out of the way of ships. They are, I think, some of the most important words that I have seen written.

Lieutenant A. GILMORE: I would also remark upon the great difference there is in the classes of vessels. In the old time of war we had the three-decker and the two-decker, the three-deckers leading the van, and the two-deckers forming the second line. Now, we have a great variety of vessels, and if our fleet went into action it could not adhere to the order of battle. The Admiral would have to form a different arrangement. It would be useless for the "Warrior" to attack a two-gun turret vessel, or for the "Wivern" to fall foul of such a ship as the "Magenta." The fleet would have to be arranged in such a way as that the ships composing it shall be able to attack vessels of a corresponding class.

Captain HOUSTON STEWART: May I be allowed to make one other remark? I was much struck with what Admiral Ryder said about the revolutions of the engine. I dare say Captain Pellew remembers that we had to introduce that practice in the Mediterranean fleet. I happened to be Flag Captain, and had charge of the "Marlborough." I found I could make nothing of it, until we introduced this system of directing the number of revolutions, and the captains of the other ships, with great success, adopted it. I dare say Captain Pellew remembers how, after a few days, the ships manœuvred almost as one ship. Captain Pellew will, in his reply perhaps, refer to the method of using boats for the instruction of Officers. We older hands, though we may hope once more to smell salt water, are right, I think, in considering what measures should be taken for bringing up the young officers, so that those who are now coming forward in the Service may learn to manœuvre ships as they now learn navigation, and every other useful science. I would, therefore, ask Captain Pellew, in his reply, to give his opinion as to the use of boats for instruction; because I was really struck with the great utility and the facility of giving instruction to the officers, as Sir William Martin did in the Mediterranean, by means of boats. I am sure that those midshipmen and officers who took any part in the manœuvres, directly any signal was made to their ship, would have known what was to be done; they would not have had the slightest necessity for thinking what they were to do, or where they were to go. The only thing they had to do was to manœuvre their ship, but how to manœuvre her, they had learned before. I cannot see that there would be any expense or trouble in employing boats for instruction. Captain Colomb has told us that the new signal-book is coming out. I am sure it will be a very valuable one. But why should not the Captains of the ships in the Channel squadron learn

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manœuvring with boats as we did in the Mediterranean. We saw every manœuvre that a fleet could perform :—"Line ahead!" "Line abreast!" &c., without the slightest mistake, and after very little trouble. An officer might learn this system of tactics from boats alone.

Captain F. A. CAMPBELL, R.N.: I can bear testimony to the truth of what has just fallen from Captain Stewart. It may be thought that the practice is not kept up. It is kept up in the squadron, at least it was a year ago. After Sir William Martin's time, the boats generally assembled two or three times a week, under different Captains. It was, no doubt, an excellent school for young officers; the midshipmen, lieutenants, and captains themselves learned a great deal from it. When under steam, if a signal was made, they knew at once what they had to do, from perpetual practice in Valetta and elsewhere, under oars.

Captain HEATH: It fully bears out what I said of the fears I have, of too much science being introduced into this practical business. My first experience in learning fleet manœuvres was also in boats, thirty years ago But if the captains have to go into their boats to learn the existing manœuvres, why, you will have to rely in future upon captains who have pulled about with your midshipmen in their boats. I mean to say that it is an argument for keeping the thing as simple as you possibly can. If the old, simple rules are not known to the captains, how are the new and more intricate rules to be known to them?

Captain FREMANTLE: I do not think the old rules were very simple. They were rather complicated; they were obliged to be complicated on account of the sails, and of those that were put in afterwards for use under steam—namely, beginning from 0 up to 100; I think there were 30 or 40 of them. I only speak from memory; there were very few, and, if I may presume to say so, I do not think they were particularly well put together.

Captain PELLEW: Captain Stewart, in a very flattering manner, has asked me to give my opinion about the use of boats for the purpose of teaching the manœuvring of the fleet. You learn a great deal from boats; a great deal in the way of practical experience. Of course it was easier in the Mediterranean, where you have no tides, and generally calm weather, than it would be in our harbours at home; though I have no doubt we could get the time in the summer to do it.

The CHAIRMAN: I think we all row in the same boat. With few exceptions we do not know much about the subject, because we have not had the opportunity of learning it. I am sorry that with all our zeal we have such a small attendance of Naval Officers to listen to Captain Pellew's able and interesting paper. I compliment him upon the very able manner in which, in a small compass, he has told us a very great deal.

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LECTURE.

Friday, April 12th, 1867.

MAJOR GENERAL SIR VINCENT EYRE, K.C.S.I., C.B., R.A., in the Chair.

THE UMBEYLA CAMPAIGN.

By Captain FOSBERY, V.C.,* Her Majesty's Bengal Staff Corps.

The CHAIRMAN: I have much pleasure in introducing to you Captain Fosbery, who will read us a paper on the Umbeyla Campaign, in which he bore so distinguished a part as to earn the decoration of the Victoria Cross. Although a subject of four or five years' standing, I have no doubt it will be found to contain some novel features most interesting to the present audience.

Captain FOSBERY: I should have hesitated to accept the kind and flattering invitation given me to address you to-day, had it not been for some considerations which I will, if you please, briefly lay before you.

My hesitation was caused by distrust in my own power of telling the story of this campaign as it should be told. I felt that in the short space of an hour it would be most difficult to fill in those details which give life and reality to the fossil remains of a despatch or blue book, and general interest to figures, only to be exhumed from those difficult strata by some unusually patient explorer.

On the other hand, I reflected that the story contained many episodes of interest to every soldier; and that were it told, however imperfectly, some valuable political and military lessons might yet be drawn from it; some more wide-spread interest not unworthily excited in scenes where have been gained the experiences, formed the reputations, or dug the graves of some of England's ablest soldiers; some attention, drawn perhaps also to considerations which, unknown or unheeded *now*, may by-and-bye force themselves (and terribly, too, should we be unprepared) on the attention of the entire nation.

India for England, as Algeria for France, has been aptly called the nursery of soldiers, but whilst France has kept her whole army

* Now Major Fosbery.—ED.

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instructed in the lessons learned in that nursery by a portion of it, we have neglected on our part to do the like. Algeria gave France her Zouaves and Spahies; her military rifle was invented for its conquest; the tentes d'abri were devised to lighten the equipment of her flying columns; and an admirable system of mountain artillery and military train, so organised as to unite rapidity of movement with efficiency in action. A hundred other military improvements, thus originated, have pervaded her entire army to its great and lasting benefit.

Few French officers of standing are ignorant of the tactics to be adopted in an Arab campaign, or of the methods of maintaining, moving, and fighting with success a column in that difficult country. Their artillery, commissariat, and transport also are always ready for instant and protracted service.

Comparatively few English officers know what Indian mountain fighting means; the remainder, when brought face to face with a brave, numerous, and formidable enemy, on ground very different from the valleys of Aldershot, or the plains where so many of our triumphs have been won, are apt to find the ordinary regulations, manuals, and drill books less than what is necessary for immediate success. English courage and English resources eventually win the day, but both courage and resources are often wasted in the winning. True, we have men such as Neville Chamberlain, Reynel Taylor, Wilde, Vaughan, Green, Probyn, Keyes, Brownlow, and others, whose very names are a terror to the tribes with whom we are continually in contact; but they are so, not merely because they are brilliant soldiers or diplomatists, but because they possess a special knowledge, not possessed by the rest of our Services; an experience, too, which unhappily dies with them.

It may be objected that the Umbeyla campaign was a little war—one of those little wars we occasionally wage, which attracted the attention of not one man in a hundred in England; and further, that the soldiers present were sufficient for it. To this I would venture to reply, that ere its conclusion, the movement of troops in support extended to Meerut, more than 400 miles from the scene of action; that it caused a most grave excitement in Asiatic minds from Calcutta to Cabul, and beyond it; and that towards the end of December, 1863, on this account alone, there were no less than 25,000 men in motion west of the Jhelum, whilst 36 British officers and nearly 1,000 men, were killed or wounded, during the course of the operations. Besides this, in a country ruled by the sword, no war can be a *little* one whose result will certainly decide the attitude of the warlike tribes outside a frontier of hundreds of miles in length, and possibly excite to action the tens of thousands of secretly hostile fanatics within it; both issues hung on the conduct of this Umbeyla war, and account for the anxieties of some of the highest authorities in India. Nor was it successfully concluded, but by the determined attitude of Sir Neville Chamberlain, who (like Nelson) would *not* be recalled; of Sir Hugh Rose, who, approving his determination, vigorously supported him by a most rapid and effective concentration of troops; and finally, by the decisive action of Sir William Denison, who on his arrival, steadied the councils of the administration, and in his concise and able minute, pointed out clearly

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enough, the disastrous results of hesitation, failure, or retreat. But if this war really involved such great results as it may be shown it did; if similar expeditions are to be again undertaken (on a continually increasing scale), and should it not be impossible that we may become eventually engaged in very extensive operations in these same mountains for the very maintenance of our Indian supremacy; then, it cannot but be well to draw attention to points, the careful consideration of which, may materially influence our success. On these grounds, therefore, I venture to deliver this lecture, asking you to bear with its many imperfections.

After a brief description of the *locale* of the war, its causes, and the enemy against whom it was fought, I propose to consider its plan, conduct, and results, and conclude by drawing attention to such considerations as seem most worthy of attention.

In doing this, I will if you will permit me, here and there quote from descriptions of my own, written at the time, and repeat occasionally such opinions then expressed, as have not needed modifications by the light of knowledge subsequently obtained.

I must further express my great obligations to Colonel Adye's able *résumé*, entitled Sittana, and to the sketches, photographs, and plans which he has kindly permitted me to copy.

The ostensible cause of this war was the insolent conduct of a body of Hindostanee Mussulmen, fanatics of the Wahabee sect, under chiefs named Moolvie Abdoola and Syud Mobaruck Shah. This body of men, recruited from lower Bengal, and further strengthened by the presence of rebel sepoys, who had escaped their just chastisement at the time of the great mutiny, had taken up their residence at Mulkah, a town on one of the lower spurs of the Mahabun mountain, or "hill of the mighty forest," as its name stands translated into English. This colony, whose earlier history is well told in Cunningham's history of the Sikhs, until the year 1858, had been placed at Sittana, within sight of our frontier (the opposite bank of the Indus). From this point they crossed the river by night, harried our villages, drove off our cattle, and carried away the wealthiest men for ransom into the fastnesses of the hill. This became unendurable, and in that year a force was placed under the command of Sir Sidney Cotton for their chastisement.

Crossing the river, he captured and burned the village, and bound by treaty the surrounding tribes, to prevent the return of the colony who had, with few exceptions, escaped. They soon built a new town at Mulkah, in the heart of the Mahabun, and for a time remained quiet. But it was well known to our frontier men, that the behaviour of this colony, placed beyond our borders, was but the manifestation of the sentiments of the fanatics within it, by whose contributions it was maintained, and by whose orders it acted; and the Umballa State trials of 1864 showed conclusively how widely-spread was the conspiracy, how perfect was the organisation, and how well prepared the treason of those who planted this thorn in our side.

It might have been well to have let them live as a political barometer. had this been the only point in question—two thousand enemies, more or less, being of little consequence to our Indian Army. But when

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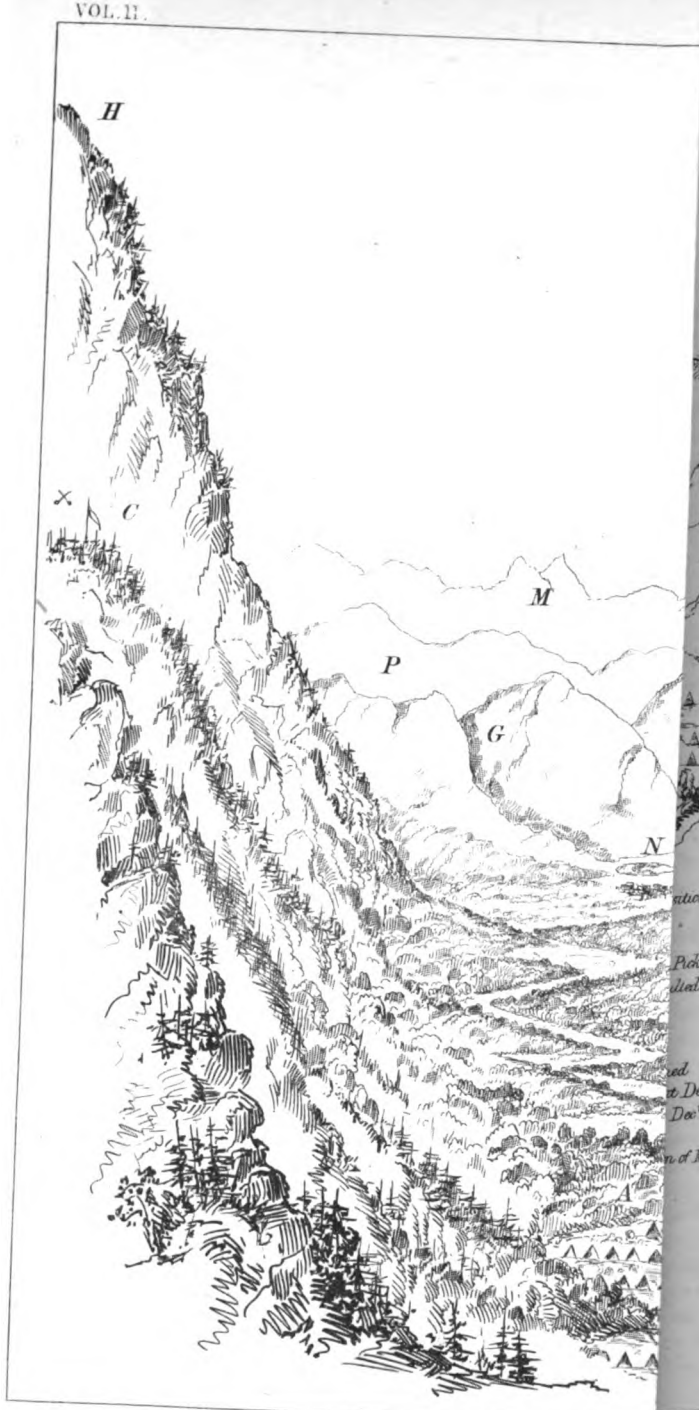

J. Jobbins

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they returned from their town of Mulkah to Sittana, and commenced plundering on our territories, drilling on the one side of the Indus, and firing at our troops on the other, it became evident that something must be done.

This conduct did not only mean that some few fanatics were getting troublesome, but it meant also that the tribes on our border were becoming careless of treaty, and defiant of our power, and might any day join in the depredations, and share the plunder of the lawless colony, all participations in whose actions, however, they as yet disavowed. It also meant that a disaffection was spreading within our own territories, and as we had not then the clue to the soul of the question, it became necessary to apply an adequate punishment to the body represented by this Sittana colony, and act on mind, as has been so often done before, by dealing with matter.

The question then arose, how were they to be reached and effectively punished, placed as they were in the immediate neighbourhood of powerful tribes, whom it was undesirable to provoke, and with whom they might take sanctuary and so escape. A glance at the plan of the position they occupied will show the difficulties under which we laboured.

Mulkah, their settlement, was most strongly situated in a cup, or hollow, high on one of the spurs of the great Mahabun mountain.

This mountain, by some supposed to be the Hill Aornos, which cost Alexander the Great more than two years of fighting and a large proportion of his army, is situated in a bend of the Indus, isolated from the remainder of the chain of hills, on the one side by the Chumla valley, and on the other by the plains of the Eusofzaie, our proposed base of operations. Could it be possible then, without serious resistance, to gain the line of the Chumla Valley holding the Eusofzaie, as we did, on the one hand, and the fords of the Indus on the other, the colony, and, as we hoped, the war, would be confined to this corner; and to the attitude assumed by its tribes, the Koodookehl and Judoons, which would almost certainly be hostile, the force to be sent against them could afford to be indifferent.

Not so as to the other tribes, however, who were warlike, numerous, and formidable, the best swordsmen and the best marksmen on the frontier and but few amongst whom had, from past experience, learned to respect our military power, or dreamed of the extent of our resources. With the Boneyr tribe, indeed, we had been always on good terms, and with them our line of route would bring us most nearly in contact. But it soon became known that the colony, hearing of what was probably in store for them, had sent out emissaries amongst the tribes for the purpose of arousing the fanaticism, always latent in the mind of every Mahomedan, however lax his religion, and the fears and jealousies of a naturally suspicious and jealous race. There was an excitement amongst them which might possibly be allayed, but on the other hand, easily increased into active hostility. Fanaticism, moreover, is one of the most capricious as well as the most formidable of human motives.

The problem, therefore, was to reach the Chumla Valley with as

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little offence to any one as possible, having done which, every hour's march would remove us further and further from those to whom it was inexpedient that offence should be given. There were two ways of doing this, either by the Durrun pass or that of Umbeyla. The use of the Durrun pass, from the nature of the country, would entail more labour on the troops. That of the Umbeyla offered a greater offence to the tribes with whom we desired to remain on good terms, for it was the one communication between the key of the Boneyr country and the plains below, and the Goroo Mountain, which rose from the stream at the bottom of the pass, to a height of 6,000 feet on its northern side was exclusively theirs, while the pass itself they considered exclusively their own also. That we had foreseen this difficulty, was proved by the means taken to overcome, or rather *get round* it.

The force to be employed, consisted of some 5,600 men of all arms, including the 71st Highlanders, 101st Bengal Fusiliers, half battery of Royal Artillery, under Captain Griffin, the Huzara and Peshawur Mountain Train guns, 100 sabres of Colonel Probyn's famous regiment of Horse, 100 of the Guide Cavalry, 4 regiments of Punjaub Infantry, 1 of Goorkahs, and the 32nd Bengal Native Infantry. It assembled at Nowakilla, in the Eusofzaie, on the 12th of October, 1863, and General Sir N. Chamberlain assumed the command on the 17th.

The greatest secrecy was observed, not as to its objects, but as to the means to be taken for attaining them.

The Durrun Pass had been the one selected by Sir Sidney Cotton for an expedition into the Mahabun in the year 1858. It was but six miles distant from the camp at Nowakilla, and through the tribes prepared for defence at both points, it was natural that they should suppose we would select this one in preference to the other.

In order to confirm them in this opinion, a small force under Major, now Colonel, Keyes was sent to encamp opposite its mouth, and this manœuvre was instantly followed by a concentration of the enemy, who began stockading the pass, and showed themselves in large numbers on the hills flanking it. On the night of the 19th October, General Chamberlain broke up his camp; and transmitting orders to Colonel Keyes to join him at Pernouli, and a proclamation to the Boneyr tribe, assuring them of our friendly intentions towards themselves, he marched on Roortum Bazaar, *en route* for Umbeyla.

His march was well contrived, a description of it therefore may not be uninteresting. A night march is always an uncertain and trying thing; but by forethought and good management, the troubles of this were reduced to a minimum; still it had its disadvantages. In night marching, there is always, first of all, the difficulty of getting clear of camp. In India it is a scene of most extraordinary, and at first apparently hopeless confusion. The groaning of camels, the unparliamentary language of men who break their shins against tent pegs, or tumble over ropes, the shouts of those unfortunates who have lost their regiments, horses, or servants in the darkness, mixed up with the blows of mallets on the tent pegs, and words of command from every possible direction, make a din that must be heard to be appreciated; even after the *fall in* and when every man is in his place.

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the guides are generally missing, and on this occasion were so, long enough to deserve the fervent blessings of the entire force, which they duly received as they went to the front.

At last the advance sounded, Field Officers mounted, the British subaltern threw away his cheroot and fell in, and the long column was off, steering to the N.N.E., through a dark and cloudless night, and feeling its way at the rate of some two and three-quarter miles an hour. The night was cold, and the wind from the hills bitter and piercing. The road, a village track at best, gradually became merged in fields and cultivation. But presently, at half a mile distance, a bright light, like a star, flashed out, and gradually grew larger and brighter, and on this the march was directed. As we advanced, a second and a third appeared at regular distances. The first soon resolved itself into a blazing fire of dry thorns, sheltered by a mat screen from the wind and the view of the hills. Round it were seated some four or five gipsy-looking men. These rose as the force came up, and, shaking back their long hair, gazed in undisguised wonder at the great moving cloud of dust, out of which flashed into their circle of light, now the long teams and bright appointments of the heavy field battery, now the red coats and white helmets of the British line, the Khaki uniforms of the frontier force, or the blue turbans and glittering lance points of Probyn's horse. Then, as the last of the column passed, they turned and dashed out the fire, whilst another and another springing up beyond, defined the distant road, and guided the force from light to light till the morning. Here and there a deep sandy ravine occurred, when strong working parties of Europeans, with drag ropes, ran the guns down and up the steep banks, and kept all going. At last came the chill wind that always precedes the first streak of day, so well known to every one who has marched by night in India; then a greyish light, and the first note of some wild bird from the jungle, and then the jagged hill line began to show out, high against the eastern sky, like a ruined wall, seemingly close to us. Presently the day broke, the force mounted a long slope, and halted in echelon of regiments on high ground above Roostum Bazaar, having travelled about eleven and a half miles since starting. After a hasty meal and deliberate pipe, we were off again, leaving the round towers and mud walls of Roostum to the left, and changing direction more to the eastward, we pushed through the lower grounds towards the base of the hills. These soon began to close in on either hand. A glance to the right showed us the baggage of Keyes' column winding through an opening in the lower range, and looking picturesque enough in the blue misty air of the early morning. At last we entered a long, broad valley, which narrowed gradually as we proceeded, till, after crossing a small clear stream at Surkhowa, we were fairly in the mouth of the Umbeyla Pass.

The pass proved to be nine miles in length, and was for the last portion of it, intricate and difficult. Nor was it possible to maintain much military order, except at the very slowest pace. Here was seen a mule being dug out of a crevice by sappers, while H. M. Infantry halted and swore at the delay: there a jamb of mountain train ammunition

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or stores, the beasts kicking and screaming twenty deep in an angle of the water. Now a few inexperienced men would push forward in a likely direction on the flanks, and being brought up by impenetrable jungle, or the edge of a precipice, return growling. Then a block would occur to the front, when the entire force sat down to drink cold water or smoke the pipe of patience. Fortunately there were none to hinder. Had the enemy occupied in any force any one of the formidable defensive positions which the pass offered, there might have been trouble; for once a false alarm of fighting, to the front, showed how difficult it would have been to have united the troops in any part of the pass for attack or resistance. But the brunt of what little fighting took place, had been borne by the advanced column, who had crowned the heights on both sides of the gorge, and proceeded according to the established rules of mountain warfare.

As the hills bounding the road were frequently intersected at right angles by almost impassable ravines, it was at first sight a puzzle to us how this was managed so quickly and efficiently as to keep the leading column well in advance of those that followed, and the pass at the same time entirely free for them.

The process was pretty and soldierlike: two of the leading companies were pushed up on either flank, the enemy if disposed to be troublesome, got a shell from the mountain train, then the infantry charged, and cleared them out, and that pair of hills was safe. Coming down at their leisure, the men fell in in rear of the column, whilst two more companies ascended the next hills in their turn and covered the advance, which was steady and well conducted, as might have been expected from its leaders. At last the force reached and occupied the most formidable gorge of the pass, at that point whence its streams flow two different ways, to the rear to join the Cabul River, to the front to traverse the Chumla Valley and fall into the Indus under the dark shadows of the black mountain. Then however the march ended, neither guns, commissariat, or baggage having arrived; nor was all fully up until four days afterwards. Those four days were sufficient to complete the combinations and assemble the forces of the tribes whom the route chosen, had exasperated, and the two miles of that march unfinished on the 21st of October, remained so until the 16th of December, two months later.

Pending however the arrival of the baggage, on the 22nd of October, General Chamberlain sent out a party of cavalry under Colonel Probyn, to reconnoitre in the plains beyond, sappers to improve the road by which the force was to reach them, and a regiment of infantry to occupy the pass in front during both operations. The cavalry avoiding the village of Umbeyla, which practically though not geographically belonged to Boneyr, took the southern side of the plain and proceeded as far as Kagah without resistance, finding the road practicable for troops of all arms. On their way they perceived large bodies of the tribes assembled at the Boneyr pass, who however professed their intentions to be peaceable unless an attempt should be made to enter their pass or country.

The time occupied in the reconnaissance however was sufficient to

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change their resolutions, and on the return of the cavalry, Colonel Probyn found himself opposed by a considerable body of the enemy, posted in strong ground to dispute his return. He therefore on their commencing to fire, at once charged them vigorously, cutting his way through them and went up to camp. The sappers and the 20th Native Infantry then became engaged, and Colonel Brownlow was followed in the dark and difficult ravine, by a large body of the enemy, who not only fired continually, but closed with the rear guard, sword in hand, at every moment.

Two miles of this work brought him to the pickets of the camp, and these in their turn becoming engaged, a heavy night attack followed, blood was shed on both sides, and we were at once committed to a war with the tribes, of which no one could guess the extent. To have advanced now would have been to abandon the line of communication by the Umbeyla pass to the mercy of the Boneyr tribe. And to take the line of the Chumla Valley after abandoning it, would have been to place the force between the Boneyr tribe and their allies on the one hand, and the tribes of the Mahabun on the other, with an unknown country, whose physical difficulties had already been found to be formidable enough, increased ten-fold by the hostility of these tribes in rear.

The Umbeyla pass was said by those who had seen *both*, to be more formidable than that terrible Khyber pass so disastrous to the army of Cabul; the Mahabun mountain was absolutely unknown. Under these circumstances General Chamberlain decided, and doubtless most wisely, to maintain his communications with his base, and suffering himself to be attacked where he stood, to give the tribes a proof of our power, which should convince them of the helplessness of long withstanding it. He accordingly took up a position on the crest of the pass, and pushed up outposts on his flanks on either side, giving orders that these posts should be strengthened by stockades or breastworks as far as possible. He also ordered up the troops necessary for keeping open his communication, and placing his guns in position, remained for a time on the defensive.

The situation was truly a peculiar one. The small portion of the pass occupied by the force (about 200 yards in width at that point), and filled with huge rocks in every direction, was dominated on both sides by almost precipitous hills; 1,500 feet up, the distance between them was only 800 yards, which gives a fair idea of their sharp angle of ascent.

From below, the ridges immediately commanding the camp were plainly visible, and on these it was proposed at first to establish outposts, but on reaching these points, it was discovered that they in their turn were dominated by strong positions further up in the hills, and it thus became necessary to push post after post, into the mountains one either hand until the process was only stopped at the Eagle's Nest, on the left flank, and the Crag picket on the right by the impossibility of adequately relieving or supporting the troops at greater distances. As it was, no relief from below could reach the Crag picket in less than 45 minutes, nor the Eagle's Nest in less than one hour from the time of leaving the camp below, and as these posts were

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invisible from thence, assistance when required must be sent for, which practically doubled the distance.

Roads too had to be made to connect these posts and breastworks for their defence, and the work entailed great fatigue on a large proportion of the force.

But whilst the inefficiency of his carriage, together with the unforseen difficulties of the pass had so far thrown out the General's calculations, as to place him in an almost purely defensive position, the dangers of that position were unfortunately augmented by the nature of the defences constructed. When timber, earth, or stone is available in large quantities, it ought not to be difficult on favourable ground to throw up such a defence as might be held against any enemy unprovided with artillery.

The examples we have seen of Bootaneese bamboo forts, Burmese stockades, or New Zealand pahs, show that the merest savages know how to do this, and to do it well. We however, as a rule, I fear, neglect such precautions, and over-confident in our arms and courage, often content ourselves by placing the smallest and most unscientific obstacles between ourselves and our enemies. The slight dry stone walls at first built here, barely covered their defenders from the enemy's fire, in some cases the troops inside could scarcely fire over them, in others the enemy could; flank defence on the one hand, and defilade on the other were almost entirely neglected.

These little posts were too often constructed rather with regard to the immediate presence of materials and natural form of the ground, than to its defence, and the garrisons who occupied them suffered accordingly. The Eagle's Nest picket lost half its garrison from the enemy's fire during four hours from these causes alone, and the Crag picket, though strongly garrisoned, was twice taken by the enemy, simply because no flanking fire on any one of its faces was provided for. The moment such fire was obtained by building of a trifling outwork, the enemy ceased at once to attempt it.

We are strong, well armed, and well disciplined, and knowing ourselves to be so, we are too apt to forget that fanaticism, the *elan* of a body of men who are content to die for one good blow at their enemy, will often give them for a moment a superiority over the best troops in the world.

It has often been asked why do tyrants so rarely die by the hand of the assassin. The answer is simply because no conspirator can be found, notwithstanding all professions to the contrary, who will undertake to fire the shot or plant the dagger, with the clear understanding that his death, without hope of escape, must follow the next instant. All hope to get off somehow, and the act of looking back mars the enterprise.

But amongst the fanatics of India you will find hundreds of men who will band themselves together with the very purpose and intention of gaining a death at your hands, so long as they can kill you. They accept and triumph in the death itself, without *arrière pensée* of any kind, and thus become enemies not to be despised by the most skilful and bravest soldiers.

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Of this character were some of those who opposed the force under General Chamberlain, and to their reckless bravery are to be attributed many of the casualties that took place. In some instances they actually clutched the muzzles of the cannon, cutting desperately at the gunners, in others they threw themselves fearlessly at the slight breastworks, leaping, sword in hand, amongst their defenders, and either becoming the leaders of a successful assault, or dying the glorious death they fairly earned.

On the 26th of October, the enemy attempted the extreme right of camp, but were detected in the act by Colonel Keyes, who soon after daylight took the initiative, and drove them along the crest of the ridge from one position to another, until they finally took post at a place known afterwards as the Conical Hill. As they were in great force and he had but 200 men, he halted on the ridge opposite, at a distance of about 650 yards, and sent to camp for reinforcements. These, consisting of mountain train guns, European marksmen, and a Goorkah regiment, owing to the distance, did not arrive until nearly two o'clock.

The range of the enemy's position having been then ascertained by means of rifle shell, and fuzes cut and adjusted accordingly, marksmen were placed in position, and given their distance; the guns masked by sections moving in front of them, were dragged by hand into position. The sections then suddenly wheeled back, and the guns and marksmen opened at once on the top of the hill. The effect was almost instantaneous; the enemy completely taken by surprise at the weight and accuracy of the fire so suddenly brought to bear on them, began to waver, when Colonel Keyes, at the head of his regiment, dashed across the plain, stormed the position, and drove the enemy pell-mell in the direction of Laloo, capturing a standard, and cutting them up in the operation and several of the force, then returned to camp.

The men of Colonel Keyes' regiment, the old Cokes Rifles, so distinguished at Delhi, performed a sort of war dance round the captured standard, to the music of the sirinai, an instrument in sound much resembling the bagpipe, the Europeans loudly cheering them as they marched past. An officer paused to look at this performance, and admire the fine physique and warlike bearing of these wild soldiers. Ah, said another, "you are astonished at this; that's only a standard they have there. At Delhi these Pathans used to do the same thing, but they did it round the heads of their enemies."

Though beaten however, the enemy were not discouraged; they had arranged for a simultaneous attack on both flanks of the camp, but somehow the Boneyr people failed to keep to their engagement, which gave great offence to their allies. The next day, however, the former determined to redeem their pledge, and threatened the Eagle's Nest and pickets on the Goroo mountain in great force. The General, therefore, reinforced these posts, placing the left defences under Colonel Vaughan. High above the Eagle's Nest picket placed on the extreme right of the line of defence stood a large sunga or breastwork of stone, which commanded that work, whilst its entire face was subject to enfilade. To its left and at a lower level was a line of troops, posted amongst broken ground, whose left flank rested

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on a knoll, on which were placed the mountain train guns. Presently the enemy gave a great shout, and waving their swords and standards, rushed down to the attack, their marksmen dropping into every place of shelter, and firing rapidly to cover the advance of the sword and spear men, who came up to the attack with great boldness; but between the base of the slope and the rocks on which the picket was placed, was a little plain, some 80 yards in width, and here they became fully exposed to the fire from the work, which was so close, accurate, and deadly, that four hours' fighting left them foiled, with a loss of some 300 killed or wounded. The European marksmen alone are said to have put *hors de combat* 180 men, losing 7 of their own number, whilst an English officer and 40 other men lay killed or wounded inside the post, being nearly half the number originally employed for its defence.

This action necessitated a far stronger occupation of the slopes of the Goroo Mountain, and still further weakened the force in the valley below. Breastworks were now built across the ravine at the two extremities of the camp, batteries constructed, and guns placed in position for their defence, and stone walls run up for a considerable distance into the hills on either bank, to cover the troops employed.

On the following day the Boneyr men came in under a flag of truce, asking permission to carry off their dead. They did not seem humbled or beaten: frankly admitted their defeat, but, pointing towards the great mountain, said there were many warriors there to take the place of those they were now carrying for sepulture to the burial-places of their fathers. Certain, however, it was, that some of their principal men had fallen in the assault, and there were vacancies at their council fires, which the tribe could ill afford. They now established a series of small posts on inaccessible points of the hill, outside the defences, and searched out with an accurate and constant fire the greatest part of the camp, causing several casualties, and specially annoying Captain Griffin's battery. To this fire it was extremely difficult to reply with effect, and the marksmen of the European regiments were constantly employed in this service.

On the 30th, having previously received large accessions of force, with whom came also the Ackhoond of Swat, a spiritual leader, whose position as regards these tribes is compared, by Sir N. Chamberlain, to that of the Pope of Rome towards Catholic countries, they planned a simultaneous attack on the right, left, and centre of the position. That on the left, or Eagle's Nest, was abandoned on the failure of the other two, which were, however, delivered with great energy and considerable judgment.

The Crag picket, which you see in the sketch here, had hitherto been only occupied by Colonel Keyes (whose position is shown below) as a post of observation, and on the night of the 29th was occupied by twelve men only. The enemy, however, seeing its importance and the command which its possession would give them, approached it towards morning, overpowered and drove out the feeble garrison, and occupied the summit of the rocks with some 250 men, the remainder waiting on the ridges in the neighbourhood to take advantage of the confusion which their fire must produce at daylight in the posts below.

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The nine survivors of the picket, however, retreated only as far as the rocks at the base of the Crag itself, and, opening fire on the enemy above, who were busy strengthening their position, called loudly for support.

Colonel Keyes at once answered this appeal. Taking with him an officer and ten of his own men, he proceeded to join them, directing his adjutant, Lieutenant Pitcher, to bring up more men as fast as they could be got together.

By dawn he had with him some seventy-five men at the foot of the rocks, on whom the enemy poured a continuous and heavy fire, hurling down at the same time huge stones, which caused several severe hurts.

As soon as it was light enough to distinguish friend from foe, and his left flank was covered by Colonel Brownlow's corps, who moved out into the ravine below, he divided his force into two parties, gave the order to fix swords, and sounded the charge. The Pathans gave a wild shout of "Allah! Allah!" (in the name of God) and rushed at the Crag, scrambling like cats from rock to rock, by ways through which but one man could pass at a time, in the face of a hot fire and heavy shower of rocks and stones.

This daunted some of the men, and Lieutenant Pitcher who was leading at the time being stunned by a heavy stone, but *two officers*, Colonel Keyes and another, and about twenty-five men, arrived at the summit where they became engaged in an exciting hand-to-hand conflict. Colonel Keyes was severely wounded, but the place was won. The nature of the struggle may be judged of from the fact that sixty of the enemy's killed and wounded were left on the ground, three standards captured, and the rest of their force was so much discouraged by the action as to retire from that flank altogether. Meantime an attack had been made on the front of the camp, which was repulsed by the 71st and 101st regiments, aided by the fire of the guns in position, and a dashing charge made by the Goorkahs, in which, however, the latter suffered severely. Their dead, when brought in, were found to have been shockingly mutilated by the enemy, and from this time it came to be an understood thing, that in this war, quarter would neither be asked nor granted on either side.

A story is told of an officer who, seeing a stir upon the hill side amongst the European troops sent out to the scene of an action fought two days before, and a large group assembled about some object on the ground, ascended a rock above them to learn the cause. A curious sight presented itself. In the centre lay the mutilated body of a slain comrade, and at its head stood a non-commissioned officer with a Testament in his hand. Man after man came up, and to each was administered a solemn oath that from that day out they would neither save nor spare, but pay that debt to the uttermost.

That oath was afterwards well kept, and many a tall Pathan recreant sepoy and fanatic Moslem read his fate in the stern eyes and pale compressed lips of those who had sworn to give no mercy.

The enemy's attacks now became intermittent, and for a curious reason. Before dying, it behoves every good Mussulman to repeat a short prayer, failing which his soul is exposed to vexatious delays

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and inconveniences on its road to paradise. An exemption to this rule is, however, permitted should his death take place on his Sabbath, our Friday.

In their wars with one another, the sword or small matchlock ball was seldom so instantly fatal as to preclude the performance of this rite. Our bullets, shrapnel shot, and shell, were, however, on trial, found to be less considerate, and many a pious Mussulman pined in the cold, outside that heaven he had died to win. There was but one remedy, and in future they fought their more considerable actions on their Sabbath only.

This arrangement proved welcome to the force. The change of base was effected, Pemouli being selected as the depôt in place of Roostum Bazaar, and the Pass of Kanpoor made practicable for the communication, to replace that of Umbeyla, which it was proposed to abandon. Preparations also were made for transferring the whole force from the ravine itself and the heights of the Goroo Mountain, to a position on the south side of the pass at the head of this road, and communications were pushed on towards the plain in advance, for the future use of the force.

To do this with safety, strong covering parties were sent out to cover the working parties and sappers employed. A Friday intervening, however, during the continuance of these operations, these parties placed at a considerable distance from camp, from which also they were separated by deep and all but impassable ravines, became surrounded by the enemy, and only regained the position with the loss of their leader, Major Harding, who, refusing to leave his wounded to the mercy of the enemy, paid for his chivalry with his life, of Ensign Murray, of the 71st, and Lieutenant Dougal, of the 79th, who were both killed, besides 34 others killed, and 37 wounded. Amongst the latter were Oliphant, of the Goorkahs, a man of a name famous in India, and the gallant Battye, of the Guides, brother of that Battye who like him was struck down in the fore front of battle, and whose latest words when dying were "Dulce et decorum est pro patria mori." His conduct, and that of other officers on the summit of the hill, alone saved the covering parties from a more serious disaster; and it was not until late at night that all returned to camp. Thence could be seen bodies of the enemy with torches, following on the line of the retreat, slaying the wounded, and plundering the dead. Stragglers now and then arrived; and one man, a private of the 71st, who had been stunned by a heavy fall amongst the rocks, did not arrive until dawn on the following morning, having escaped, by what seems almost a miracle, the parties of the enemy who patrolled the sides of the hills.

This was the first success which the enemy were able to obtain, and it encouraged them proportionably. After this, however, there was again a pause, during which the enemy received reinforcements from Bajour and the more distant tribes, and their parades on the level ground near Umbeyla became imposing by their strength, and picturesque, from the numbers of gaily coloured silk standards which they carried, and the costumes of the different mountain men.

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On the night of the 12th of November they attacked the Crag picket, which had been greatly enlarged, and now contained 160 men; and from nine o'clock in the evening until three in the morning, to the number of some 3,000 men, used every effort to force the post, Colonel Brownlow, who had before so successfully defended the Eagle's Nest, was, however, in command, and judging by the attitude of the enemy that an attack was imminent, further strengthened the position, during the last few hours of daylight, by every means in his power. He threw up traverses to intercept the heavy enfilade fire from the opposite ridge, 400 yards distant, and by dusk had every man in his place, and prepared for the coming attack. Presently Captain Hughes' guns from the position in rear, threw a couple of shell into the enemy's watch fires, which they at once quitted, and descended into the ravine below. Here they were sheltered from the fire of the work, and nothing but a dull murmur told the defenders that a numerous enemy, bent on attack, lay within 80 yards of their slight defences.

Now and then could be heard some impatient chief marshalling his followers for attack, and, last of all, the deep voices of the Moolahs, or priests, who blessed their "enfants perdus," and promised the joys of paradise to those about to die. Then a pause, and then arose a shrill, wild cry, so wild and shrill that for a moment no one recognized it as the war cry of the Moslem "Allah! Allah!" but it was instantly taken up by 3,000 deep voices, and, with a wild shout, their heavy column quitted its cover and rushed at the breastwork.

Colonel Brownlow waited their approach and then suddenly poured into the mass a fire so close and deadly, that nothing living could face it, and perforce they retired; in half an hour they returned to the attack, and were repulsed as before. Again and again they attempted to storm, and still the fire of the works mowed them down as they came to close quarters. At last making a most determined attack on both sides of the weakest angle of the post at once, hurling large stones on its defenders, whom they confused and overwhelmed by the suddenness and vigour of this new mode of attack, they got at the wall itself, pulled it down, threw the stones on the defenders within and were masters of the corner.

Many men of the garrison commenced to retreat, but Colonel Brownlow, calling for volunteers and getting but four or five, rushed at the place, turned the invaders out, rebuilt the wall, and held it for the remainder of the night. The guns also from their position, 250 yards in rear, guided, as to range and direction, by voice from the post, opened fire, throwing shell over the top of the rock into the ravine beyond and doing good service, and though attack after attack followed, Colonel Brownlow maintained his position with success, until the morning.

At three the fighting ceased, both sides being weary, and the enemy having suffered considerable loss. Then a strange incident occurred. One of the enemy taking shelter under a rock within 20 yards of the post, called to the garrison in Pathan patois to know if they were not tired of all this noise and gunpowder—for his own part he freely

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confessed he was—to this a reply was made that they were quite ready to go on. "But," said he, "don't you think singing is better than fighting, sit quiet for a little and I will sing"—and without further preface he began singing in song after song, the wild strains of love and war, which stir the hearts of these mountaineers. The troops on our own side, many of them recruited from these very hills, took up the chorus and from the deep ravine, where his friends lay, came a chorus louder than ours, and now and then a sound of applause which plainly showed how numerous and how near they were. He was addressed from the post and complimented on his singing and bravery, and asked if he would not take service with the English, who would duly estimate both qualities; to this he replied, "we have quarrelled and not yet settled our quarrel, when that is done I will consider"—and firing his matchlock at the post in defiance, he dived into the ravine, and was no more seen.

Colonel Brownlow's men who had been 48 hours on continuous duty were relieved soon after daybreak by Captain Davidson and men of the 1st Punjaub Native Infantry. The enemy almost instantly made a new attempt, stormed the post before the men were fairly in position, killing Davidson, who refused to leave his post and died as a soldier should, and a large number of the new garrison with him. The place had therefore to be retaken, at the point of the bayonet, by the 101st Bengal Fusiliers, under Colonel Salusbury. But pending their arrival, the advance of the enemy was stopped by the fire of mountain train guns, and the heroic behaviour of three or four officers, notably Lieutenants Pitcher and Young, who collecting a handful of men charged them so vigorously as to save the main pickets, and give time for the arrival of reinforcements.

Colonel Keyes, though still suffering severely from his wound, showed the greatest coolness, and held the breastworks successfully, at a time when everything was in the utmost confusion, when there were but few good men available for defence, and a mass of camp followers, panic-struck soldiers, and baggage, blocking in their flight, the only road to the camp below. Colonel Salusbury, as soon as he arrived, at once formed his regiment for attack and stormed the Crag, heading the assault, which was made with that dash for which his regiment, as well as himself, have long been celebrated.

Slight skirmishing followed this affair, but on the 18th of November the arrangements for the movement having been completed, General Chamberlain decided on retiring his left flank and concentrating his whole force in rear of what was before called the "Right advanced pickets."

Drawing off by degrees his men and material from the slopes of the Goroo mountain by 10 A.M., on the morning of the 18th of November, his force, having performed a most delicate and difficult movement, had occupied, without molestation, a strong position on the southern side of the pass, and had changed their base of operations, line of communication, and military position at one and the same time. But here the enemy interfered. This instance, were there no other, would conclusively shew the justice of the opinions of Sir N. Cham-

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berlain, and those who supported him, in his refusal to retreat, not only on account of the impolicy, but also on account of the danger involved. The enemy mistook this change of position for retreat, and thereupon organized one of the most formidable attacks delivered during the whole course of the operations.

They followed up the retirement in great force to the lower pickets of the new position, drove out their defenders, and, but for the determined resistance of the troops, would have entered the camp itself. Here were killed Smith, of the 71st; Chapman, the Adjutant of the 101st; Murphy, of 14th Native Infantry, and Lieutenant Jones, a volunteer from the 79th. Lieutenant Chapman, knowing his wound to be mortal, begged, but in vain, the retiring troops to assist Captain Smith, and leave him to his fate. Both were, however, killed, and their bodies not recovered until the 21st.

On the 20th the Crag picket, then garrisoned by two companies of European troops, was again taken by the enemy. Two Officers were killed, together with a large number of their men; and Major Delafosse, one of the two survivors of the Cawnpore Massacre, in vain displayed the greatest bravery, in the hope of rallying the men, and still holding it.

The post was retaken by the 71st Highlanders, under Colonel Hope, who, moving out from the breastwork, advanced, in face of a tremendous fire, steadily, and without a single break, to the summit, to which two roads had by this time been constructed. This they did without the smallest appearance of hurry, their pace being regulated by Colonel Hope himself, who, briefly saying, "71st, you have to take "that post, and to follow me," led them up the hill, and was the first man to enter the work. Here, however, he was unfortunately severely wounded, as was General Chamberlain, who accompanied the assault, and the force was thus deprived of the services of its two Senior Officers.

This was the last great attack delivered by the enemy. On this day, too, the late Major Hugh James, Commissioner of Peshawur, arrived in camp whilst the fight at the Crag was going on, having just returned from England. He was supposed to know more of the characteristics, relationships, and interior policy of the tribes, than any other man who had occupied the same position. At the same time, General Chamberlain received a telegram authorizing him to abandon his position and retire on Pemouli, but this, though wounded severely, and in spite of the heavy losses the force had sustained, he refused to do. Major James supported him in this determination, representing to the Government that though matters were very serious, retreat could only make them worse, and set himself to sow disunion amongst the tribes pending the arrival of reinforcements. This he did in a simple but most ingenious manner, which shows the suspicious nature of these men, as well as their simplicity. He had with him a body of native levies, who formed a means of communication between ourselves and the enemy. Some of these levies he assembled in front of his tent, and, producing a huge bundle of letters, told them they must take them to the enemy's camp.

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Then, seeming to reconsider the question, he took out a certain number, saying, Ah! well; I won't write to so and so; he has so little influence; or so and so, for his followers are so few; and making some disparaging remark about each chief named, he burnt the letters addressed to them, to the number of about one-half. The rest he charged the spies to give to the remaining chiefs, with a request to take them away from the council fire, and read them quietly.

His orders were carried out, and whilst one-half were away reading their letters, the others, jealous of their distinction, cross-questioned the spies, and discovered from them the remarks which had been made on themselves by the Commissioner. On the return of the other chiefs, they were called on to show their letters, and these were found to contain nothing beyond a few ordinary compliments. "Ah!" said the others, "that won't do. Where's the letter promising you money for "deserting our cause?" These, of course, never existed, and the poor men had none to show; but the neglected chiefs could not be persuaded to believe it, and such mutual mistrust was engendered that the Boneyr tribe never again united to attack us; so that the attack which entailed the fall of the Crag picket, proved to be their last.

The force now, with but small interruption, awaited its reinforcements, the enemy during the same time also receiving great accessions of strength. Indeed, the excitement spread along the whole border, and attacks were made on us at other points by tribes who had long been neutral or friendly. On the reinforcements fully arriving, and the force reaching a strength of 9,000 men, General Garvoch, who succeeded Sir Neville Chamberlain when the latter was disabled by his wound, commenced a forward movement, in anticipation of the enemy's proposed attack on camp, of which he had received intelligence.

Moving out with two brigades, he drove them along the ridges of the southern range, and took the Conical Hill by storm, as also the village of Laloo, which he burned. He then bivouacked for the night. In pursuance of their original plan, however, large bodies of the enemy had entered the valley, and learning how large a number of troops had quitted the camp, made a strong and well sustained attack on the advanced positions. These, however, under Colonels Brownlow and Keyes, resisted all their efforts, and mortars having been brought into play for the first time, searched out with their fire the ravines which had before sheltered their parties, almost within stone throw of our works; and Colonel Keyes at length, by a brilliant charge, drove them pell-mell into the valley below, whence they did not return. On the 16th the force descended from the hill, taking and burning the village of Umbeyla, and offered battle to the enemy in face of the very key of their country. Colonel Probyn had led his sabres down from the heights, nearly 2,000 feet, into the plains by paths supposed to be barely practicable for mules, and menaced any of the enemy who might venture into the open. Their cavalry prudently concealed themselves in the broken ground, and saved their lives thereby. Captain Griffin, who had got his half battery down carrying the guns and carriages on elephants, now horsed it, and passing the village at a gallop, took up a position on the right, and opened fire with shell and shrapnel. The enemy

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gradually retired, and two regiments thrown out as skirmishers pressed their movement. Presently, however, a horde of Ghazees, or fanatics, 250 strong, came out of a ravine which had hitherto concealed them, and in an instant dashed at the line, cutting right and left, and causing some confusion. The regiments were driven back by the mere force of the onset, almost as far as the supports which Colonel Turner had echeloned in their rear. The enemy, who witnessed the conflict from the pass above, already began to descend the pass with loud shouts. The retirement, however, lasted only a moment, and, closing with the attacking party, the Pioneer regiments exterminated them to the last man.

This action closed the campaign. The Boneyr tribe submitted, and asked for orders. Their allies had now fled, and they were informed by the Commissioner that, to prove their good faith, they must send a force to Mulkah, and destroy it. They gave hostages for their performance of this compact, which they religiously fulfilled, several British officers accompanying them, to see the work done. Amongst these was Colonel Adye, and the drawing before you is a copy of a sketch of his, taken on the spot, and showing a portion of the town. The troops, with the exception of a small column sent to coerce some of the smaller tribes, who had not yet submitted, now returned to their cantonments.

The main points to which I think the story calls attention are the following:—1st. As it was by the deficiencies of carriage hastily collected, and organized on no regular system, that the force was delayed long enough to permit of the combinations of the tribes, it will be seen that for successful hill expeditions, excessive lightness of equipment and efficiency of transport should be insisted on. 2nd. Considering the delays which the bringing up of reinforcements entailed, no force should attempt to enter these hills without a strong reserve close at hand. 3rd. Mountain-train guns of greater length of range and accuracy, are required. The 12-pound mountain-train howitzers did good service, but the 8-pounder guns comparatively little, being inaccurate at any distance, and their light projectiles being useless against the smallest dry stone wall. Batteries of European artillery, having Armstrong or Whitworth guns, of not more than 2½ cwt., each, and of long ranges, might with advantage be organized for frontier service.

4th. A body of marksmen, carrying long range rifles, and trained, organized, and equipped for the arduous work of the hills, would form a most valuable adjunct to any force destined to operate there. The mountain men are themselves first-rate marksmen, seldom throw away a shot, and respect an enemy for the like qualities; they despise him for the want of them. The marksmen of Her Majesty's regiments employed during the campaign, did excellent service, but not being trained to the work, suffered severely from its harassing nature, and from wearing dress and accoutrements designed for the parade-ground, or at all events for tolerably level country. 5th. We learn that no care expended on the field works, however small, was thrown away; whilst the want of it was often disastrous in its results. No officer should be ignorant of the necessary precautions to be taken in tracing a work, nor the height and proportions of his breastwork.

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6th. Abatis, if constructed at all, should be solidly made and judiciously placed, and traverses thrown up where necessary, and all this, not under the enemy's fire, but as a part of the plan of the work during its original construction. Then, as the front or flanks of any position taken up amongst such mountains as these, is sure to have deep ravines in its immediate neighbourhood, which will always serve as *places d'armes* to the enemy, mortars should be provided to dislodge them from situations in which neither musketry nor artillery fire will touch them. It continually happened during the Umbeyla war that such ravines formed the cover from which their most formidable assaults were delivered, and until the last few days the force had no means of dealing with them until the attack had actually commenced. Hand grenades too, and some means of throwing a strong light in the front of the positions during the night attacks, of which many took place, would have been of most essential service.

The Americans have perfected a system of this kind; they also, instead of abatis, used telegraph wire, tied from tree to tree, which had the effect of stopping a charge, and detaining the enemy for a few moments under fire; this was exactly what was required here. Strong wire, such as is used in the telegraphs in India, is also the very material required for supporting and binding together an abatis not exposed to the fire of artillery.

The Americans applied artificial light for both attack and defence in a most ingenious manner. The light was so arranged that a screen left either the defenders or attacking party in complete darkness, whilst throwing a strong reflection on their enemies, and some simple contrivance for producing and directing light in such a country as this would be of the greatest advantage.

The hand-grenades, improvised of soda-water bottles filled with powder, and having a small piece of port fire stuck in the neck, were wholly useless. Few men had the courage to light them, and the throwing them over the breastworks, in their hurry to be rid of them, extinguished the port fire ere it was well lighted; thus of all that were prepared, not one did any service. The fuze of a hand-grenade cannot be so extinguished, and a supply of them would have been most useful.

At the commencement of this lecture I alluded to the necessity that might some day arise for extensive operations in these hills, for which it would be ill to be unprepared. In vindication of this allusion, allow me to draw your attention to the map before you, which indicates both the nominal frontier of Russia, and her actual advance beyond it. This may not be an immediate menace to our Indian possessions, but I do not hesitate to affirm that the matter needs immediate and earnest attention, wise forethought, and careful preparation. It has been of late years the fashion to deride what used to be called Russo-phobia—a feeling which in old times led to the occupation of Cabul, and our connexion with the Dooranee Empire.

Our statesmen now advocate a policy of non-intervention in central Asia, and the consequence is, that whilst Russia is advancing steadily to the line of the Syr Daria—Alexander's base of operations for the con-

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quest of India—we are unwilling to give even moral support to those who are opposing to this progress, a gallant, though unfortunately useless, resistance.

But whilst in Europe a policy of non-intervention may be understood, and possibly even respected, in Asia, it is quite unintelligible to the native mind, and is but too often supposed to be dictated either by weakness or fear. We now find that the envoys from Bokhara, who during a whole year in vain solicited our aid, even in the shape of one or two British officers to sit at their councils (could no more be done for them), are at present at Moscow; and the negociations on which they are engaged, will doubtless lead to a further extension of Russian prestige and the Russian frontier.

That Russia keeps a keen eye to India, notwithstanding what may be said to the contrary, may be gathered from the fact, that her spies penetrated the entire country during the mutiny, and that letters written in Russian narrating every circumstance that occurred were captured at the time. Where, as in Asia, *prestige* strengthens almost incalculably the hands of the ruling power, her gain must be our loss, and her successes, even though not directly against ourselves, may lead to most serious trouble by the encouragement they will give to the lawless men of our border.

Major James suggested, and Colonel Adye strongly recommended, a change of policy towards these men, and that instead of vainly attempting to coerce them by force, we should rather endeavour to win them to our side by measures of kindness and conciliation. This may or may not be possible, but either way, the surest guarantee of peace, is a perfect readiness for war.

Time will not permit my further pursuing this subject, but should I have succeeded in drawing the attention of others to one or two points which I so sincerely believe to require it, this lecture will have fulfilled its object, and the story of the Umbeyla Campaign not been told in vain.

Ladies and Gentlemen, I thank you for your kind attention.

The CHAIRMAN: I am sure that all present will agree with me, that we have heard a most admirable lecture upon a most important and interesting subject. I think few will be disposed to deny that such papers have very great value to all Englishmen, and that the present paper may be said to have a special value, when, as Captain Fosbery has pointed out, our northern frontier is likely to become the scene of still more important military operations than any that have hitherto occurred in that region. Such life-like sketches as we have heard from one who has himself borne a part in the active operations of the campaign, must always be of great interest. Certainly, it may be considered as one of the advantages of this Institution, that it presents opportunities for explaining to Englishmen that which at all times is so difficult of apprehension. Nothing, perhaps, is more difficult than for English people to understand the occurrences which take place from time to time in so distant a region as India, and which exercise a very important influence upon our national history. I am sure the present

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company will support me in offering our cordial thanks to the Lecturer. As Colonel Adye is present, and has himself entered largely into the subject of this lecture, perhaps he will favour us with a few observations.

Colonel ADYE, C.B., R.A.: I should like to explain for a moment with regard to the position of the Russians in Central Asia. If you look at an old map of Russia, of 40 years ago, you will find that the Russian frontier was far north of the Jaxartes, whereas we know what has happened since the Crimean war, that they have taken the line along the Mustau mountains. They have got steamers on the Caspian; they have sunk a line of wells across the desert; and they have got steamers on the sea of Aral. They established themselves, first of all, on the Jaxartes, with forts down that river; therefore, that became their line. In the meantime they also advanced from Semipolatinsk. In the year 1844 they came down this line, and we know now that they have got their outposts on the crest of the Mustau mountains. We have at the present moment frequent telegrams from St. Petersburg of fighting in Bokhara. They are doing on the Oxus what they did a few years ago on the Jaxartes, and I believe they have got as far as Charjooe. They are, apparently, taking a line down the Oxus. Our advanced post is at Peshawur; there is, therefore, now nothing between the Russians and ourselves but Affghanistan, of which Cabul is the capital. What appears to me is this, that we should cultivate, if possible, the friendship of the Affghans, because they are not only a very warlike and fine race of men, but they really hold our natural frontiers: that is to say, they hold the great line of the Hindoo Koosh mountains. At the present moment, we have a very bad and dangerous frontier; we are in the air. I do not say we should advance, because we should get into interminable war with these people; but I do think, if we could succeed in gaining their friendship and confidence, we should have in that, a great barrier against the Russians. I do not say that the latter are enemies, but they may be enemies; at all events we have this powerful nation coming down towards us. We have already advanced our frontier 1,600 miles to Peshawur, and I think everybody will see that these Affghan mountains form the natural frontier for the English.

The CHAIRMAN: The meeting is very much gratified by what Colonel Adye has said. I trust that Colonel Adye may be induced to give a lecture upon the subject. In the present critical state of matters, such a lecture would be of very great advantage, not only to members of this Institution, but to the British public.

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LECTURE.

Friday, June 7th, 1867.

MAJOR-GENERAL THE HON. JAMES LINDSAY, Vice-President, in the Chair.

THE CONSTITUTION, COMPOSITION, AND RECRUITING OF THE FRENCH ARMY.

By MAJOR-GENERAL G. BALFOUR, C.B., R.A.

BEFORE entering on the subject on which I have the honour to address you, I am anxious to explain the nature and extent of my enquiries into the military conscription of France, and the object with which I undertook these enquiries, in order to enable you to judge how far the information I am about to lay before you is deserving of confidence.

Soon after my return from India, in 1863, I had occasion to investigate the nature and extent of the control exercised over military expenditure in France, with a view to ascertain how far the system of control which I had aided in carrying out in respect to the Military Finance of India, resembled the efficient French system. These enquiries necessarily brought under my notice many parts of the French military system, amongst others, the arrangements for supplying the French army with recruits, at first only in so far as regards the cost. Having however been appointed a Member of the Recruiting Commission formed by Her Majesty during the course of last year, to enquire into the recruiting of our own Army, I was thus led to contrast the recruiting system which obtains in France, with that of our own. From my previous enquiries into the military expenditure of France, I had acquired some knowledge of the best sources for obtaining information in regard to the details of the French conscription; the opportunity for using this information arose out of the Report and recommendations of the Recruiting Commission. I am not here this day as the advocate of that Commission, but it will be remembered that it was formed, and the instructions were framed for its guidance, prior to the great events in Germany. The nature and

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extent of the Report were necessarily limited by the instructions, and the recommendations, no doubt, appeared meagre and restricted, when the public mind was excited by the rapid successes of Prussia, and the preparations then making on the Continent, especially in France and Germany, to raise the military forces to a very high scale. No doubt this can only be most successfully done by the great command which continental nations have over supplies of men, from the power of conscripting every man fit for service into the Military and Naval services; but I may add that there are recommendations in the Report on Recruiting, which, if fully carried out, would remove some of the difficulties experienced with our system of voluntary service in obtaining recruits, and in rapidly increasing the military strength.

The state of public opinion gave rise to discussions both in public and private, as to our available resources for defence in case of necessity. The Statistical Society (on whose Council I have the honour to serve), ever alive to the importance of examining those measures that concern the welfare of the country, considered that the information I appeared to possess on the military conscription of France, might advantageously be communicated to the Society. Accordingly, in compliance with the views of the Council, I read before that Society, in the early part of this year, a portion of a long paper now in course of publication in the *Statistical Journal;* and the Council of the Royal United Service Institution having been pleased to invite me to contribute my mite towards the vast store of military and naval information already collected in its Proceedings, I shall now endeavour to give, in outline, the substance of the Statistical paper above mentioned.

Prior to the Revolution, the army of France was composed of Frenchmen voluntarily enlisted, of foreigners induced to take military service in France, and of a Militia formed of the contingents that the villages were bound to supply. The large increase made by the Revolutionary Government to the military forces, rendered necessary the adoption of more efficient means than voluntary enlistment, for the maintenance of the Army.

In 1789, the conscription was first proposed to the National Assembly, but was rejected as a criminal attempt on the liberty of the citizens; and it was decided to continue to rely on voluntary enlistment. In 1791 however, the volunteers who were at liberty to return to their homes at the close of each campaign, quitted the armies on the frontiers in spite of the prayers and even the menaces of the National Assembly. In 1792, the Minister of War pointed out the difficulty of recruiting the Army, and on the 22nd July, of that year, the country was declared in danger. New battalions were then organised, and the patriots of other nations were appealed to, to furnish fresh foreign legions. These measures would however still have been insufficient, had not the Convention on the 24th February, 1793, authorized an annual requisition of 300,000 National Guards, selected from the fit men of from 18 to 40 years of age—unmarried, or widowers without children—an immediate call of the same number being made in that year. Still more stringent measures were however deemed indispensable in

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order to protect France from external attacks. Accordingly, on the 23rd August, 1793, on the proposal of Carnot, the National Convention decreed the levy *en masse*, and decided that until the enemy should be driven out of the country, every Frenchman should be permanently liable to military service. This measure produced the anticipated results, the population of France—then 25,000,000—supplied an army of 425,000 men, which freed the country from invaders.

On the 5th September, 1798, (19 Fructidor, an VI) on the Report of General Jourdan, the Directory and Councils of the Republic passed the conscription law, which for the first time made military service obligatory, and under which every Frenchman was liable to become a soldier, and serve for the defence of his country. Exemption was granted only to men married before the law was passed, and to those who had paid their debt of service in previous wars.

The conscription included every Frenchman between 20 and 25 years of age completed, and the youths drawn were divided into five classes, according to the year in which drawn. The number of conscripts called into active service was also ordered to be annually fixed by a special law. The above limitation of age applied in all ordinary cases; but under extraordinary circumstances, when the country was declared in danger, the levy *en masse* might be authorized, as in 1793.

This extreme measure could however only be of short duration, and was accordingly modified by the law of the 8th March, 1800 (17 Ventose, an VIII) under which the power of *remplacement*, allowing the conscript to be replaced by a substitute, was re-established, under certain restrictions. Thus, it was only allowed in the case of those admitted to be unequal to the fatigues of war, and those who might be considered more useful to the State, by continuing their professions and studies; and as these points were subject only to the judgment of the sous-prefets, who decided on the advice of the maires, there was necessarily great partiality in favour of, or against individuals. Conscripts thus replaced, continued however on the conscription lists, with a view to the contingency of the substitute deserting; and only obtained a final discharge, when the substitute died under the colours, or was discharged on account of wounds or ill health, or at the close of the legal period of service.

The conscription was maintained as the means of carrying on the struggle into which France had then entered against Europe, and supplied the resources in men, by which the first Empire was enabled to carry on the campaigns during the first 14 years of this century. The burden thus laid on the French population was, however, very heavy, and at times excited great discontent. Its abolition by the Charter of 1814 was therefore generally welcomed. It is calculated that during the existence of the conscription law, from 1798 up to 1814, about 2,500,000 men were called under the colours, but only 2,100,000 were actually incorporated, so that about 400,000 must have been refractories or deserters.

In the law of 1818, initiated by Marshal Saint-Cyr, under the restoration, the word conscription was not even mentioned. Voluntary enlistment appeared to be the principal element of recr[illegible] the

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"appel," or levy, as the subsidiary means. The effective peace strength of the army was then fixed at 240,000 men, and was proposed to be kept up by annual supplies, not exceeding 40,000 men. The contingent was apportioned between departments, arrondissements, and cantons, according to the number of their population; and was formed by being drawn by lots amongst the youths of 20 years of age. The rights to exemptions and dispensations were wisely defined, and claims decided on by a Council of Revision, whose character was a sufficient guarantee, both to the State and to individuals, for the fairness of their award. Voluntary enlistment into the Army was allowed, but was gratuitous, the payment of bounty being prohibited; and a re-engagement for a second period of service, though permitted, only gave a right to higher pay. Under the law of 1818, the full period of service was fixed at 12 years, of which 6 were in the active army, and 6 in the veterans; but it was modified by a law of 15th January, 1824, which abolished the corps of veterans, and reduced the total period of service to 8 years, either in the active army or in the reserve of young soldiers. The strength of the annual levy was then increased from 40,000 to 60,000 men.

Remplacement was authorised without administrative intervention, except in so far as regards establishing the fitness of the *remplaçant*; the person thus replaced, remained liable to be called into service during a year, in case of desertion. All those drawn by lot, or their *remplaçants*, were incorporated into the Army, but might be left in their homes, to be called into active service as required. Any further demands on the population were to be provided for by a special law.

After the Revolution of 1830, it was decided under the law of 11th October, 1830, that, instead of fixed contingents of 40,000 and 60,000 men, as determined by the laws of 1818 and 1824, the strength of the contingent should in future be fixed by special decree every session.

The main principles of the law of 1818 were, after a trial of 13 years, fully maintained, by Marshal Saint-Cyr's measure being embodied in the law of 21st March, 1832, which continues up to the present day to regulate the recruiting of the land, and marines or sea forces of France.

The utter insufficiency of voluntary enlistment for recruiting the French Army under ordinary circumstances, is considered in France to be fully established, by the fact stated when the law of 1832 was brought forward, viz., that during the 11 years between 1818 and 1828, the number of voluntary enlistments did not, on the average, exceed 6,395 annually. In the proposals recently made in France to alter the existing system, it is stated that during the last 20 years—not taking into account the engagements contracted by youths of from 18 to 20 years of age, which are in fact, for the most part, only anticipatory of their being drawn under the conscription—the number of voluntary enlistments has never exceeded from 3,000 to 4,000 in any one year. At critical times, the national spirit of patriotism has never failed to call forth a large number of volunteers in France; but these temporary responses to danger form no permanent resource for the maintenance of the Army.

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The important point in connection with the conscription, to which I wish to draw your special attention, is the means of supplying the Army with the numbers annually required to maintain its established strength; and as this depends on the number of youths who annually complete the age of 20 years, at which they become liable to military service, I must briefly explain the state of the population during a series of years.

It will be found on examination, that only a very small augmentation has taken place during a period of 43 years, in the population of the French Empire.

In 1821 the population was found to be 30½ millions, and by the returns compiled in 1866, it was shown to be 38 millions, being an increase of only 7½ millions. The number of youths who in the year 1821 became available for military service, as having completed their 20th year on or before the 31st December, was found to be 288,828. These were the survivors out of the 464,562 males born in 1800, giving a percentage of 62·17 surviving to complete their 20th year. In like manner the number of youths who in 1864 were available for service, as having completed their 20th year on or before the 31st December, 1863, was 325,127; giving a percentage of 64·64 survivors out of the 502,927 males born in 1843.

The aggregate number of males born during the 43 years extending from 1800 to 1843, I find to be 21,587,548; and the number who, during the interval between 1821 and 1864, became liable for military service by reason of completing their 20th year, was 13,201,110, giving a percentage of 61·15 of survivors to births on the whole period.

The percentage of males who survive to enter their 21st year has, however, varied considerably in different years of this period. It was only 58·22 during the five years from 1820 to 1824, but was as high as 64·04 for the four years between 1860 and 1864; thus indicating a considerable improvement in the life rate of French males.

I have now before me a table of the number of males born in each of the 64 years from 1800 to 1864. The largest numbers were 522,116, born in 1859, and 513,204 in 1814. The lowest numbers were 460,910 in 1847, 463,443 in 1855, and 464,562 in 1800. This table therefore shows but little increase to the resources of men during the past 64 years.

The diminution of the number of male births during the latter years of this period, will necessarily diminish in future years the number of youths available for military service.

The largest number who in any one year of this century completed their 20th year was 326,298, in 1834, being the survivors of those born in 1814. The nearest approach to this number was in 1863, when the youths placed on the conscription list for 1864 numbered 325,127, being the survivors out of 502,927 males born in 1843. The annual report for 1865 on the recruiting operations of the French Army shows a falling off, only 321,561 youths having completed their 20th year on or before the 31st December, 1864; these being the survivors out of 492,703 males born in 1844.

The number of youths who may be expected to complete their

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twentieth year on or before 31st December, 1867, does not exceed 299,000, being only about 10,000 above the number who survived in 1820 out of those born in the year 1800; shewing a very small increase in the recruiting resources of France since the beginning of the century.

The number of survivors in the present year may be considered to be estimated tolerably accurately as above, judging from precedents.

The number estimated to survive out of the 492,703 males born in 1844 was entered in the printed table now before me at 320,256; but since then the census tables have been published, shewing that 321,561 youths were placed on the conscription list in 1865 as actually available. This gives an excess of only 1,300 in the actual over the estimated number, and is a fair illustration of the extent of the improvement in the present life rate of France, as compared with that of former years; so far indicating a corresponding extent of improvement in the condition of the people of France.

I must now explain the mode of carrying out the conscription. Out of the French Revolution arose the excellent system of strict registration of births, deaths, and marriages. The birth of every male is registered in his own commune; and every year, all the youths surviving to complete their twentieth year on or before the 31st December, are placed on the conscription list of the following year. The whole number of that age are called the "class" of the year.

The Legislative Chambers of France annually fix the total number to be drawn by ballot as conscripts from the class of the year. This is called the contingent of the year, and the Emperor apportions it among the 89 departments, in the proportion which the contingent bears to the number of youths of 20 years of age available in each department, the census tables published every five years being taken as the data for fixing the proportion. The sub-division of this number amongst the cantons of the respective departments is made by the prefets on the same basis; and the several communes in each canton furnish youths according to their available numbers. So strictly are the registration and census tables kept, that very few youths ever escape being inscribed on the Lists. Omissions may occur in the first year or two, but as soon as discovered, the youths are included in the conscription lists of the following year. Those that escape this vigilance and attain their thirtieth year, then become free; but not more than five or six thus escape in a year. The number who, having been inscribed, fail to present themselves when called on to join the ballot for the conscription, is considerable; but they are returned as refractory or insubordinate, and are placed first on the list as soon as found. It is only after the lapse of many years that they cease to be liable to punishment for thus evading their responsibilities; and their civil rights being placed in abeyance until they have fulfilled the conditions of the law, it is the interest of every citizen of France to present himself for ballot in the commune to which he belongs, at the time that he becomes liable to military service, and is inscribed on the lists.

In order to maintain the most careful supervision over the recruiting

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of the Army, Councils of Revision are every year formed in every department of France. These councils are composed of high officers of state, entrusted with the duty of supervising the selection of men for the military service. I find that, excluding subordinate officers, no less than 801 officers of rank and position are employed during 40 to 50 days in each year, on the recruiting service of France. The daily and hourly employment of these officers is closely scrutinised by the Minister of War; the time must be carefully accounted for, and any remissness is remarked on.

These officers may be thus enumerated:—

89 Prefets.
89 Councillors of Prefecture.
89 General Councillors.
89 Councillors of Arrondissement.
89 General Officers.
89 Sous-Prefets.
89 Sous-Intendants.
89 Military Medical Officers.
89 Commandants of Depôts.

The proportion which the military strength, including those in reserve, as well as under the colours, bears to the population of the country, is another important point in correctly estimating the recruiting resources of France.

In 1832, when the annual contingent of conscripts drawn from the fit males of 20 years of age was fixed at 80,000, there was nominally, on the aggregate of the contingents drawn from seven years' classes, a total of 560,000 men, either in reserve or incorporated with regiments; but after deducting the *non-valides*, or unfit men, the number was really reduced to about 500,000, being about $\frac{1}{64}$th of the then population of 32 millions. If this proportion were maintained, with the population of 38 millions, as shew by the last census, the aggregate number of fit men obtainable from the classes of seven years would be 593,750; not very far from the number (600,000) considered, until lately, sufficient to protect the honour of France, and maintain the country in security. It does not appear, however, that the aggregate of seven years' contingents even of 100,000 can supply 600,000 fit for service. Since 1832 the number of *non-valides*, or unfit conscripts, has increased, so that a contingent of 100,000 men supplies only 72,000, or for seven classes about 504,000, including soldiers under the colours and in reserve.

As already stated, the strength of the annual contingent is every year fixed by a special decree of the legislative bodies. Its strength has varied considerably during the past 50 years, but, on the whole period, it has steadily increased. From 1818 up to 1823 the strength of the contingent was only 40,000. In that year it was raised to 60,000; and in 1830 to 80,000. In 1854 the contingent, which had up to that year continued to be fixed at 80,000, was, in consequence of the war in the Crimea, raised to 140,000. The same number was called

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out in 1855 and 1856, and authorized for 1857, but the close of the Russian war allowed of the strength being lowered to 100,000. On account of the war in Italy, the contingents of 1858 and 1859 were again raised to 140,000 men; but peace was made in time to allow of the contingent for 1860 being reduced to 100,000 men. The same strength of contingent has been continued in subsequent years.

It is thus seen that the demands for men for the Army have in different years borne different ratios to the population. In 1821, with a contingent of 40,000, and a population of 30 millions, the ratio was about 1,300 of contingent for every million of population. With a contingent of 60,000 men, and a population of 32 millions, the ratio was 1,850 to each million. In 1841, with a contingent of 80,000, and a population of 34 millions, the ratio was 2,400 to each million. In 1854, with a contingent of 140,000, and a population of 35 millions, the ratio was 4,000 of contingent to every million. In 1860, with a population of 36 millions, and a contingent of 140,000, the ratio was 3,900 to each million. At present the ratio is 2,700 to each million, the population being 38 millions, and the contingent 100,000.

The variations in the proportion which the strength of the contingent in each year, for a series of 18 years, bears to the total number of youths inscribed on the census lists, are shown thus:—

1847....25·92	1853....27·00	1859....45·7601
1848....26·2135	1854....46·3688	1860....32·5807
1849....26·1607	1855....45·5726	1861....31·9822
1850....26·2647	1856....43·9614	1862....31·0611
1851....26·13	1857....32·1716	1863....30·9187
1852....25·6622	1858....33·8628	1864....30·7230

The number of youths who annually survive to complete their 20th year, cannot however be relied on as regards indicating the number eventually found fit for service, nor the number actually obtained out of the fixed contingent; because all do not come under examination, and some of those examined, are exempted from service.

From the tables I have compiled, I find that out of 7,378,610 youths inscribed on the conscription lists, during the 24 years from 1841 to 1864 (both inclusive), there were 4,710,413 examined as to fitness for military service. Of these no less than 2,416,731—that is, 51·31 per cent., or more than half—were exempted on various grounds. I find that 1,634,066, or 34·66 per cent. of those youths, were declared unfit for service on account of insufficient height and bodily weakness; whilst 782,665 were exempted on grounds recognised by the State, such as being the eldest of orphans, son or grandson of a widow or of a blind father, or as having a blind or impotent brother.

Taking one single year as an example, I find the number of youths of the class of 1863 stated in the official Report on Recruiting for 1864 at 325,127. Of these, 204,870 were examined, in order to obtain the contingent for 1864 of 100,000. The number exempted on various grounds was 104,827, as below. The whole percentage of exemptions was nearly the same as for the whole of the previous period of 24

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years; but the percentage exempted on account of insufficient height and bodily weakness was somewhat lower.

Ground of Exemption.	Number Exempted.	Percentage of those examined.
Undersized	11,421	5·57
Infirmity	57,659	28·14
Eldest of orphans	2,061	1·00
Son or grandson of widows	13,381	6·53
Son or grandson of men of 70 years of age, or blind	739	0·36
Youngest of brothers, blind, or impotent	64	0·03
Eldest of two brothers drawn at the same time	85	0·04
Brothers of soldiers under the colours	16,771	8·18
Brothers of soldiers who have died on active service, or been invalided on account of wounds or ill-health	2,646	1·20
Total number exempted	104,827	51·16

Thus in 1864 there remained out of the number examined, 100,043 actually available—somewhat above the strength of the contingent required.

These figures do not, however, represent the actual effectives, because the number is subject to still further diminution, by reason of dispensations from joining the service being accorded. Those exempted on the ground of bodily weakness, and on the recognised claims above enumerated, are replaced by others inscribed on the lists, and their exemption does not therefore entail any diminution of the strength of the contingent; but youths entitled to dispensations are not replaced, and the contingent of the year is thereby diminished. Dispensations are granted to all who already hold commissions in the Army, those borne on the maritime inscription, students of the Polytechnic, members of public institutions, educational students, and those who gain the great prizes at the Universities or Institutes. They are not called on to serve, so long as they are under these categories, but, if within seven years from the time of being drawn they cease to belong thereto, they become liable to military service. During the above period of 24 years, 255,769 of the youths drawn as conscripts, were dispensed on these grounds; and the number of dispensations in 1864 was 10,739.

Other causes lead to still further diminution. During the 24 years (from 1841 to 1864), 67,607 conscripts have failed to respond to the call for service; 19,403 were not available, in consequence of the inability of cantons to supply the fixed contingent; and those in prison, in hospital, or left at home on special grounds, have increased the number of non-effective conscripts.

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The exonerations pronounced of late years, under the special law passed in 1855, allowing conscripts to purchase their discharge, have largely diminished the number of conscripts available for filling up the ranks of the French Army. During the ten years, between 1855 and 1865, there were 215,592 conscripts exonerated, by means of purchase; and in the year 1864, out of the 100,000 conscripts, forming the contingent, 20,566 purchased their discharge.

It rarely happens that the whole of the fit men of the contingent are in the first year called on to join the active Army, those not called out being included in the Reserve, and remaining liable to service for seven years. During the past few years large numbers of the contingents have been left in their homes, but these were drafted into the Army on occasion of the war with Russia, in Italy, and recently when war with Prussia appeared imminent.

It appears, as far as I have been able to compile the returns, that out of the 2,302,234 youths forming the aggregate of the contingents fixed for the 24 years from 1841 to 1864, there were 1,543,384 brought under the colours, being an average of only 64,308 per annum, apparently no great burthen for a country like France to sustain.

The great merit claimed for the continental systems of conscription, consists in the two very opposite conditions, of facilitating, both the augmentation and reduction of army strength, with great promptitude. The extensive resources in men which the conscription places at the command of foreign Governments, enables them, whilst maintaining an army at uniform but minimum strength in time of peace, to augment the military forces in time of war to a very high scale. It has therefore been the subject of most careful study on the Continent, how to adapt the several branches of the Army, to suit this power of expansion.

The French military force is a good illustration of the best way of utilising such resources; and past experience fully proves that it has been so well organised, as to allow of its being rapidly raised to a war establishment, with but little of that confusion and financial derangement so generally arising from sudden augmentations of military strength.

To this end, a peace or minimum army establishment has long been carefully elaborated for France, and agreed to by the most distinguished soldiers and statesmen of that country. The cost has been so accurately calculated and accepted by the nation, as to prevent those frequent variations, so detrimental to real efficiency and true economy. The Army establishment is seldom allowed to fall below this minimum strength; and on those rare occasions, the diminution is in general only in the grade of private soldier. The grades of officer and non-commissioned officer, are generally maintained at a fixed strength, being but little affected by reductions or augmentations. They form the permanent cadres, which are so composed as to be equally well adapted for the efficient discipline of the maximum force of privates that can be assembled under the colours, as for keeping up in the minimum Peace Army, that high state of discipline and training

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which can without injury allow of extensive incorporations of young and untrained soldiers.

The maintenance within the territory of France of the greatest possible number of cadres of regiments—with a view to a rapid augmentation of the military strength, on a well-organised and efficient basis—is an important principle of the French military system. As few as possible, of the cadres of regiments are ever detached out of France; the requisite strength for foreign service being provided simply by raising the number of privates to the war strength fixed for the cadre, and the untrained men required for the augmentation are, without deranging the corps, easily incorporated with the trained ones. Thus, the conscription, combined with this organization, supplies the Government with the means of carrying on the military duties, with that economy which is the certain result of arrangements based on order and regularity.

The other advantage claimed for the conscription is, that an army may rapidly be reduced to a great extent, without the nation being deprived of the advantage of having soldiers available in case their services should be suddenly required; but these two very different results of the conscription will be best shown by a brief account of the principal variations in strength of the French Army, within the space of a few years.

Taking the period extending from 1st January, 1845, up to 1st January, 1866, I find that the strength of the French Army in non-commissioned officers, corporals, and privates, including also the Administrative Services, Medical, Ordnance, and Commissariat, was on the lowest scale in 1845, being then only 307,844. In 1854, the year of the war with Russia, the strength of these three grades was but little higher, only 310,267; and the number of privates was only 254,766, actually below that of 1845, which was 258,219.

In 1848, the year of the change of Government, the Army was nearly at its lowest strength, and the following year it was raised 100,000; the increase being mainly in privates, the number of non-commissioned officers being but little added to. The returns of each year, following 1849, show a diminution of strength, until, on 1st January, 1854, it was lower, in privates, than in any previous year of the period, and altogether lower in numbers than in any other year, except in 1845. The war with Russia in 1854 necessitated a large augmentation, and on 1st January, 1855, the total strength under the colours was 507,432 non-commissioned officers and soldiers, showing an increase of about 200,000 above the strength of the previous year. On the 1st January, 1856, the strength in non-commissioned officers and men was 526,056; and as this was above the maximum strength for which the regimental cadres had been adapted, these were then also increased. At the close of the war with Russia the Army was decreased, until, on the 1st January, 1858, the strength was brought down to 326,874, this being the third lowest scale within the period. In 1859, the Army was again largely increased, in order to meet the necessities of the war in Italy; and on 1st January, 1860, it stood at 559,902 non-commissioned officers and men; which was the highest

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strength reached during the period. Since then the strength has greatly fallen, being reduced in one year by 130,000 men; and on 1st January, 1866, it stood at 370,667, being but little above the strength existing 21 years before. I have no doubt that it will be found to have fallen, by the 1st January of the present year, considerably below this strength, probably nearly as low as in any previous year; seeing that there were more than 52,000 men entitled to their discharge on or before the 31st December, 1866, and the incorporations and re-engagements were not, as far as I can judge, sufficient to maintain the strength as it stood on 1st January, 1866.

I have also no doubt, that the French Army will be found to have been largely augmented by the 1st May of the present year. If the larger portion of the available Reserve was really incorporated with the active Army, as ordered, its strength will have been raised to more than 550,000 men; and, with the conscripts of this year, it might reach nearly 650,000 non-commissioned officers and men. I may add, that the numbers of the cadres have varied but little during and since the war with Russia; the augmentations and diminutions made during the last 12 years being mainly in privates.

The elasticity of the conscription system is proved by the fact, that thrice during the above period, the Army of France has been at its minimum strength, almost immediately prior to great events that necessitated a great augmentation, which has been easily effected by the conscripts in Reserve being called on to join the Army.

The ease with which these great and rapid changes are effected, results entirely from the strong Reserves in men, which the Conscription Laws provide for the armies of continental nations; but there are differences as regards the extent of these resources in different countries.

In Prussia, every man fit to bear arms is for a fixed number of years made available for military service, and exemptions are very rare. In France, however, only a portion of the youths, fit for service, are liable to be withdrawn from civil life for the Army, and there are many grounds of exemption. As already shown, the proportion drawn for the contingent has, during 18 years, varied from one-fourth to one-third of those who complete their twentieth year. And even out of these, only a portion are ordered to join the active Army in the year in which they became conscripts. Thus, I find, that out of the six contingents of the six classes, from 1859 to 1864, inclusive, comprising 600,000 men, only about 175,000 conscripts were incorporated into the active Army of the land and sea forces; leaving, even after deducting the unfit, and those dispensed and exonerated, more than that number of men fit for service in the Reserve. These are at all times available in case of emergency, and, as above stated, all the conscripts, some of them having only one or two years to serve, were recently ordered to join the French Army.

The Reserve is also partially composed of old soldiers, who, having served in the Army, have been transferred to the Reserve, before having completed their seven years' service under the colours, and are

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borne on the rolls until the expiration of the legal period of service required by the conscription.

The number of old soldiers in the Reserve has varied very considerably, during the period of 18 years; the largest number being in 1861. In that year, out of 152,197 men borne on the rolls of the Reserve, 107,471 had served in the Army; this large number being attributable to the extensive reductions made in the active Army subsequent to the war in Italy. It has several times happened, however, that the number of old soldiers on the Reserve has fallen below 100, in consequence of the French Government allowing soldiers to go home on furlough, instead of incorporating them with the Reserve. There were 87,609 old soldiers discharged in this manner, in 1857, in 1858, 161,261, and 64,471 after the Italian war, in 1860.

This point of the maintenance of a Reserve is very important, in connection with the solution of the question as to how long a nation can supply men to carry on war, and what is the largest efficient force that can be kept up. As regards France, it is pretty well ascertained, that at the close of the Crimean war, her Reserve resources in men were entirely exhausted, and the Army was dependent on the annual contingent. I cannot here enter into this wide question, but I can give a few details in regard to the French Reserve fluctuations.

The Reserve, which on the 1st January, 1848, stood at 86,312, had, on the 1st January following, fallen to 14,931; the conscripts not previously incorporated with regiments, having, on the Revolution of 1848, been withdrawn from the Reserve, and brought on the rolls of the active Army. Between 1849 and 1854, the limited strength of the Army enabled the Government to increase the Reserve; which on 1st January, 1854, was 157,802 strong, and it was with this Reserve that the French army was so largely increased. The war with Russia exhausted the Reserve, for it was only 11,755 strong on 1st January, 1856. The peace which followed, and the discharges from the Army, brought the Reserve up to 149,294 men on the 1st January, 1859. The war with Italy again reduced the Reserve, and it was only half that strength on 1st January, 1861. And then, six years of peace having brought the Reserve to a higher strength than ever before, it must recently have been entirely exhausted, by incorporation in the active Army. During the period of 22 years, the Reserve was mainly composed of conscripts, many of whom never joined the Army. Its strength was highest on the 1st January, 1866, being then 220,024, of whom only 9,063 were old soldiers. On the 1st January of the present year, the Reserve was probably about 250,000 strong; and it was from this body that the Emperor drew the means of augmenting the Army of France to the high establishment of which the newspapers made mention, in reference to the threatened war with Prussia.

It is therefore evident, that when the Reserve is drafted into the Army, the maintenance of a large military force in France must be dependent on the annual contingent of conscripts. The population of France has never been called on, in any one year, to supply more than 140,000 men, and as out of these only about 100,000 have

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ever been available for incorporation with the Army, it papears doubtful whether an army of 600,000 men could be supported by the present population, in time of war, supposing that the usual calculation of one-sixth of the Force being annually expended in the field operations, is correct.

As regards the military efficiency of the Reserve, I am unable from all I have read, to offer any very favourable opinion. In each of the 89 departments of France there is a recruiting depôt, usually composed of only two officers. In this depôt are kept the returns of the men in the Reserve, and the traces of individual soldiers sent to their homes are preserved. In each of the 89 departments there is an officer of rank in command of the troops, and the Reserve is under his orders, and may be called out for drill. This however involves expense, and until within the past few years, this calling out was rare, and, therefore almost useless, and the Reserve was considered to be ill-trained, indeed, almost uninstructed. Since 1860, an attempt has been made to organize and discipline the Reserve, by assembling it for exercise in the chief place of each department. During the first year of service, the recruits are under instruction for three months; in the second year for two months; and in the third year for one month. This new system of training is, however, described as having the inconvenience of multiplying expenses. It also throws on the Major of the regiment, already fully occupied, an increase of work and responsibility.

The last report of the Minister of War mentions the fact of the Reserve having been assembled for instruction; but, as no comment is made as to the success of the measure, I am inclined to look on it as a failure. Indeed, I think any efficient system of training for the Reserve would entail a considerable outlay; and thus neutralise the greatest merit claimed for the conscription, in the economy with which the Government can fill the ranks of the army with men partially trained as soldiers.

In the year 1855 a great change was made by the Emperor in the mode of carrying out the French conscription. The right of one of the nearest relations, within six degrees of kindred, to take the place of a conscript, when desired, has always existed. The right of a conscript to find a substitute has also existed from the commencement of the conscription; but during the necessities of the Revolutionary Government the right to this kind of substitution was withdrawn, and its restoration under the law passed in 1800, was one of the boons which softened the severity of the calls for conscripts, which then commenced, and continued during the whole of the first Empire, to weigh so heavily on the people of France. During the first 14 years of this century, it was sometimes very difficult to find fit substitutes to replace those conscripts whose families were willing and able to pay; and the increased demand for such men raised the price paid for them to a considerable amount. Nor was this the only evil, for the responsibility for the continued service of the substitute remained on the conscript whose place he supplied; and it actually happened in some cases, that

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in consequence of the desertion of substitutes, a conscript was ultimately obliged to enter the service himself, from inability to provide funds to obtain another substitute. Moreover, the classes of men found willing to serve in the Army for money, were very objectionable, of such bad character as to be disliked by officers and men, and often forced to desert. As a body these men were generally denounced, and nicknamed the "sold." In order to meet the great demand for substitutes, Societies were formed throughout France, to which private persons subscribed. These Societies professed to furnish men as substitutes, but were always denounced by the authorities as supplying objectionable characters, and often deceiving private persons.

Many attempts were made to free the Army from the stigma of receiving such a class of men, but it was not until 1855 that the Emperor succeeded in partially removing the evil, and lightening the burthen of the conscription. On the 26th April, 1855, a law was passed authorising the formation of an Army Dotation Fund, under a Commission, into which a certain sum was paid by conscripts desirous of obtaining exemption, the substitutes being then provided by the Minister of War. Soldiers in the ranks were also allowed to purchase their discharge, as well as to extend their service beyond the legal period of seven years.

Any youth drawing a number which makes him a conscript of the year is now at liberty, any time before joining the Army, to demand exemption on payment of the sum fixed by the Minister of War. In like manner, a soldier serving in the ranks may at any time obtain his discharge by paying down the sum fixed for the period of service he still has to render. The rate at which conscripts can obtain exoneration, and the rate to be paid by soldiers for each year of incompleted service, are annually fixed by the Minister of War, on the recommendation of the Commissioners of the fund; the amounts thus paid being placed in the Dotation Fund, which is well administered by the Commission of high Officers, who annually report thereon to the Emperor.

These rates of payment have varied almost every year since 1855. The first rate was fixed at 2,800 francs for the conscript. This was considered to be less than the sum then paid by families for substitutes, but it continued in force during the war with Russia. In 1857 it was reduced to 2,000 francs, and in 1858 to 1,800. The war in Italy caused it to be raised to 2,300 francs, and the Mexican War, in 1862, increased it to 2,500 francs. In 1863 it was again lowered to 2,300, at which rate it stood until the present year, when it was raised to 3,000 francs. This was the highest rate ever fixed, and indicated that war with Prussia was imminent. Since the Luxembourg Treaty the rate has been lowered to 2,500 francs. This is one of the most hopeful indications of the continuance of peace.

The amount to be paid for discharge, by soldiers in the ranks, has also varied from year to year, usually rising and falling with the rates to be paid by conscripts; but has always been greater in proportion than that required for a conscript before incorporation. In

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years 1856, 1860, 1863, 1864, and 1865, the rate was 500 francs for each year of unexpired service. In 1857 and '58, when soldiers were in excess of the numbers required with the Army, the rate was lowered to 350 francs, but raised in 1859 to 400, and in 1862 to 550 francs for each year. In the early part of the present year, when the differences with Prussia began, the rate was considerably raised, but it has lately been reduced.

The funds thus paid into the Dotation Fund are applied by the Minister of War to providing men to replace the conscripts and soldiers thus released from military service. The law of 1855 enjoins that the number of conscripts exonerated and soldiers discharged by purchase, should always be somewhat below the numbers found to replace them, in order that the Army may at all times be kept complete.

A full and detailed account of all these operations is rendered year by year to the Emperor by the Commissioners, and a copy of the report is laid before the Legislative Chambers. In the report on the Fund up to the end of 1865, I see that whilst 236,840 conscripts and soldiers purchased discharge, 245,763 men were induced by bounties to continue in the Army after the completion of their 7 years' service. The actual numbers kept in the service are in reality greater, because whilst soldiers are allowed to re-engage for varying periods of 3, 4, 5, 6, or 7 years, the numbers entered in the returns are calculated on the supposition that all take service for 7 years; thus, if 7 soldiers re-engaged each for 3 years' service, they would only count as 3 men of 7 years' service.

The bounties paid out of the Dotation Fund in order to induce men to join or continue in the Army, are fixed by the Minister of War, on the recommendation of the Commissioners of the Fund. The rates of bounty are always below the sums paid to obtain either exoneration from the service, or discharge from the Army. In 1856 the bounty was 2,300 francs for a soldier re-engaging for 7 years' service; in 1857 and 1858 it was 1,500 francs; in 1859 it was 2,000; in 1861, 1862, and 1863, it was 2,200, and 2,300 in 1864 and 1865. Recently, on war threatening with Prussia, the bounty was considerably increased, but has since been diminished. The same rates were paid to men entering the Army who had not previously served. The bounties for entering or continuing in the Army are not entirely paid down on engaging; usually only one-half is paid at once, and the remainder on completing the contracted period of service. When soldiers engage for less than 7 years' service, a part of the bounty is paid annually, but in general only one-half of the yearly rate, the remainder being reserved till the completion of the period of service. All unpaid balances due as bounties are paid to the heirs of soldiers dying before completing their service.

The one great object of the law of 1855 was to encourage trained and fit soldiers to continue in the Army beyond the 7 years imposed by the conscription law. Every encouragement was given to old soldiers to re-engage after 7 years' service, bounty as well as higher pay being then given, and on re-engaging after 14 years, a further increase of pay; and though not allowed a bounty after 14 years' service, yet

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they served on for pension, which was augmented out of the Army Dotation Fund.

In 1859, the re-engagements by soldiers in the ranks were not sufficiently numerous to replace the conscripts and soldiers who purchased their discharge; and the Government then availed themselves of the power given under the law of 1855 to enlist men, who had not served in the Army. This was carried out entirely by the Government authorities, who thus practically took the place of the old Companies formed for the purpose of enabling families to obtain substitutes.

The right of families to provide their own substitutes has been continued, but restricted to the selection of those youths within four degrees of kindred of the conscript. Practically, the providing substitutes by families has entirely ceased. In 1865 the whole number thus provided was only 448, whereas in 1854, the year of the war with Russia, and before the new law was passed, there were 21,614 substitutes supplied privately by the families of conscripts.

The reports to the Emperor on the Dotation Fund, show minutely the great extent to which both conscripts and soldiers have availed themselves of the permission to purchase exoneration. In the very first year of the Fund, 1856, when war was being carried on, 22,427 conscripts purchased their discharge. In 1859 (the year of the war in Italy), the number was 38,325, and in 1860, when war was still going on, it was 23,275. In 1862 the number fell to 18,381, and in 1865, to 18,777. It will be interesting to see the effect that the expected war with Prussia this year has had on the purchase of exonerations from liability to military service. The number of soldiers who have purchased their discharge has also been considerable. In 1855, they were 3,268; in 1856 as many as 5,524; but only about 6,000 in 1858 and 1859, the number gradually diminishing with the continuance of peace.

Another point has lately been brought to light by the purchase of exonerations. As already stated, the conscripts belonging to the contingent of each year are annually divided into two portions, one to join the Army, and the other to remain in the Reserve; and the falling off in the number of conscripts purchasing exonerations, is traced to the conscripts of the latter portion not thinking it worth while to purchase their discharge. This shows that great confidence was entertained as to the continuance of peace, and the small chance of the Reserve being called into active service.

The small number of discharged soldiers who returned to military life, although the law of 1855 permitted them to return within 3 years of their discharge, is very remarkable. The numbers who by completion of service are annually discharged from the French army, vary from 50,000 to 65,000, and out of the large number of this class living in France in 1855 and 1856, only 5,165 availed themselves of the large bounty to re-enter the army, though war was then actually going on. The largest number of discharged soldiers that subsequently re-engaged in any one year, was 4,102 in 1861. In 1865 there were only 2,454. Thus it is seen, that in general when once a French

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soldier leaves the Army he quits it for ever, and this fact is well deserving of notice in connection with the limited Reserve available in France in case of war.

The number of soldiers who re-engage before their service expires, is however greater. In 1855, no less than 23,092 re-engaged. In 1860 the number was 27,052, and next year 24,792, but it fell to 9,279 in 1865. Soldiers were no doubt at first induced to re-engage in such large numbers, by the immediate receipt, as permitted by the law of 1855—even before the expiration of their first period of service—of the bounty for the extension of service. This was subsequently altered, and accounts for the great falling off in number.

The number of substitutes engaged by the authorities to make good the deficiencies in re-engagements, has not been great, being limited to those required to fill up the vacancies caused by the purchase of exonerations, and not supplied by old soldiers. The largest number was 10,306, in 1861. In 1865 there were only 6,968.

The granting of exonerations by purchase, and the re-engagement of soldiers and engagement of substitutes by the authorities, have much diminished the severity of the conscription law, by largely reducing the number of conscripts forced into the Army. I find that the number of conscripts incorporated in the land Army during six years, including 1866, was only 136,103, being an annual average of 22,684: and this result is remarkable, seeing that the contingent has been 100,000 during each of the six years, and that out of the Army of about 436,000 men, one-seventh, say 60,000 is annually entitled to discharge.

There are great differences of opinion in France as to allowing conscripts to purchase exoneration from military service, and especially as to allowing old soldiers to re-engage after their seven years' service. On the whole, public opinion, judging by printed works, appears to be opposed to both practices, but it is certainly doubtful whether, if these two conditions did not exist, the French Army could be maintained at its present high standard, with a reserve to fall back upon, without increasing either the strength of the Contingent, or the duration of military service; and both these measures would fall so heavily on the people of France as to be borne with impatience by the people.

The operation of the law of 1855 has effected a considerable change in the composition of the French Army. The number of soldiers, who on the 1st of January 1846 were serving as volunteers, was 40,900, or 12 per cent. of the total strength; whilst twenty years later, on the 1st January, 1866, there were 72,546, or 18 per cent. of the strength. At the former date, the number of soldiers who were serving as "re-engaged" was only 12,500, or 4 per cent.; whereas, on 1st January, 1866, there were 100,307, or 27 per cent. of the strength. In 1846, the substitutes who had taken the place of relations drawn as conscripts, were 5,487 in number, or 2 per cent. of the total strength; whilst on the 1st January, 1866, they had fallen to 257. The substitutes serving as purchased men, numbered 82,759 on the 1st January, 1846; being 24 per cent. on the total strength; and on the

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1st January, 1866, they had diminished to 47,472, or about 12 per cent. on the strength. Those who were serving on daily pay and not as regular soldiers, were only 439 in number in 1846, whilst in 1866, they had increased to 13,325, or 4 per cent. of the strength.

The greatest change is however in the number of conscripts serving in the Army on their own account. In 1846, the conscripts drafted into, and actually serving in the Army, numbered 194,595, or 58 per cent. of the strength; whereas, in 1866 there were only 132,538, or 37 per cent., the percentage having decreased year by year, since the law of 1855 was passed.

The change in the average length of service of soldiers is also very great. On 1st January, 1847, there were 53,209 private soldiers, or 16 per cent. of the total strength, of less than one year's service; whilst on the 1st January, 1866, the number was only 32,187, or about 8 per cent. On the 1st. January, 1847, there were 91 per cent. under 7 years' service, and in 1866 only 67 per cent.; and in the latter year there were 33 per cent. above 7 years' service, against 9 per cent. in 1847. The private soldiers of more than 15 years' service, only numbered 4,329 in 1847, whereas, in 1866, they were 23,189 in number.

These various changes, both in the conditions under which men are serving, and the length of service of soldiers of the Army, have given rise to much discussion in France. General opinion appears to be in favour of maintaining the efficiency of the Army by having the main body of soldiers in all the elastic vigour of youth, between 20 and 25 years of age; but the advocates of this course would bring into the Army all the fit youths of the country.

This extension of liability to military service, would entail on the people of France the universal conscription in use in Prussia, instead of the more limited one hitherto in force in France. As regards one effect of that universal conscription, it was lately reported in the *Times*, that out of a thousand Germans entering into expeditions beyond seas, there are hardly more than two or three Prussians; their liability to serve in the Army preventing their leaving their own country, until they are too old to be enterprising.

The probable effect of a universal conscription in France from another point of view, may be imagined, when we consider that already, under the limited conscription, with a population of 38,000,000, the births are fewer in France, than in the United Kingdom with a population of only 30,000,000.

In order fully to contrast the effect of the two systems of recruiting the Military Forces, in France and the United Kingdom, it should be stated, that with an emigration drain on our adult population, of more than double the strength of the French Contingent annually drawn under the conscription laws, the population of the United Kingdom has nevertheless, for many years past, increased in a greater ratio than that of France.

Thus our resources in men, when called for the defence of the country, are relatively far more extensive than those of France, and

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they increase year by year. This forms good ground for preferring the voluntary service system of our army, even though it may be more directly expensive, to the conscription in force amongst Continental nations, the former having the immense advantage of permitting the full development of the race, instead of inducing, like the latter, restrictions on marriages and births. Moreover, under the Training Act, which, though never put in force, still remains on the statutes, and is capable with a few improvements of being practically carried out, we have the means of enrolling upwards of 400,000 men in England and Wales alone, for defensive purposes, and of training them in their several parishes to as high a state of efficiency as could be desired.

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Evening Meeting.

Monday Evening, June 10th, 1867.

VICE-ADMIRAL SIR HENRY J. CODRINGTON, K.C.B., in the Chair.

NAMES OF MEMBERS who joined the Institution between the 3rd and 10th of June, 1867.

ANNUAL.

Bateman, Richard S., Commander R.N.
Sloane, C. E. C. D., Captain Royal Sherwood Foresters Militia. 1*l.*
Waterhouse, Henry, Captain Lanark Artillery Volunteers.
Palk, Lawrence H., Lieut. Scots Fusilier Guards. 1*l.*

THE HYDRAULIC PROPELLER AS A MOTIVE POWER FOR SHIPS.

By Vice-Admiral G. ELLIOT.

The CHAIRMAN: I beg to introduce to you Admiral Elliot who has been kind enough to come here and instruct us this evening on the subject of a new motive power for ships. To many of us it will be new, and I am sure we shall all gain considerably by the information he is about to give us.

Admiral ELLIOT: It is not my intention to attempt any exposition of the various laws of hydraulics or scientific principles involved in the application of water to the purpose of propelling vessels. My opinion is that the laws of science which operate in the practical development of this invention are few and simple, and easily understood; and that it is owing to looking too far into the maze of science, that some clever men have fallen into such errors in prophesying the non-success which would attend this new application of water power. I regret to say that the invention has suffered much from the treatment it has received at the hands of some scientific men; but having now reached the region of success, we can afford to be generous and to forget the past: and all we ask is, that in the face of indisputable realizations of Mr. Ruthven's anticipations, and on account of the great importance of this invention for war purposes, and the enormous advantages it opens out to the science of naval architecture, our scientific opponents will in future come forward openly, and honestly support their views by argument, discussion, and proofs, as opposed to the facts we now have to lay before them.

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Were I to refer to the correspondence I have carried on for years, and show you the annoyances and disappointments I have met with, it would prove how thankless and hopeless a task it is, to become a pioneer in the cause of improvement. But if men who well know the weight of their opinions, will still continue to disparage this invention, refusing to accept the evidence of facts, it may retard the development of this new propeller, but I am convinced that it cannot prohibit its final adoption for general use.

I wish this evening to court free discussion. I will lay before you a short description of the history of this invention up to the present time, with a statement of the facts which have been realized, and I will endeavour to point out the principal features, in which this new propeller will show its great superiority over the screw or paddle. I regret to say that I come before you not so well prepared as I could have wished, as circumstances have not permitted me to devote the time which I should have desired to the preparation of this paper. I do not come here to puff up an invention, nor to make personal attacks on any one, but to meet my brother Officers in friendly discussion on a point which I am sure will interest them all; and to add my support to the proceedings of this very valuable Institution.

The idea of propelling vessels by water is very old, and many attempts have at various periods been made to adapt the theory to practice, but all unsuccessfully, until Mr. Ruthven, of Edinburgh, an engineer, in the year 1839, invented an apparatus for doing so. Under the patent then obtained, two small vessels were constructed—one of nine feet long, with steam power, and afterwards in 1844, another of forty feet. These vessels were exhibited, the smaller one on the Union Canal at Edinburgh, and the larger one on the Forth. They attracted a great deal of attention at the time, and were very highly spoken of. They had been brought under the notice of the Admiralty by Officers of the Navy, and so favourably recommended that the Admiralty requested permission to inspect and experiment on the last-named vessel, and a report, which was highly favourable, was duly made on her performances by Mr. Murray, the present Chief Engineer of Portsmouth Dockyard. Great exertions were then made by the inventor to have the invention taken up, but he was entirely unsuccessful. Few appeared to know anything of the principles upon which the vessel was propelled; and the scientific and practical people were alike opposed to it. In 1849 a few improvements were made upon certain parts of the apparatus, for which a new patent was taken out. Fresh efforts to introduce it were again made, and another small vessel, thirty feet long, was built to illustrate the invention. This vessel was placed on the Thames. A smaller one, of twelve feet, was sent to the Great Exhibition in 1851. The one on the Thames attracted, as might have been expected, a great deal of notice, and was by many most favourably spoken of; and one Steamboat Company proposed taking up the invention, but ultimately abandoned their intention stating that if successful, it would throw out of use the many boats they had then on the river. The model in the Exhibition fared worse, though it pretended to be, and in reality was, one of the most valuable

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inventions for commercial purposes in the whole exhibition; it was not so much as even *noticed* in the jurors' report. It was not until 1853, that the first vessel for commercial purposes was made and completed. This vessel called the "Albert," was built in Prussia, partly at the expense of the Prussian Government, by a Mr. Sydel, and the engines and other machinery were furnished by the patentee. It has been employed ever since, running regularly on the Oder, and has proved the complete success of the invention.

Since then, another vessel with this new system of propulsion, called the "Seraing," has been built at Antwerp, and I induced the Admiralty to send over Mr. Murray, Chief Engineer at Portsmouth, to examine and report upon her capabilities. I have a copy of the letter which was sent to the Admiralty by Mr. Murray after he had inspected the vessel, but it is too long to read it through. He reported favorably of what he saw, and recommended this mode of propulsion for adoption, especially for war vessels; although as far as the inconclusive evidence he obtained would enable him to judge of the speed obtained, as compared with the paddle in a sister vessel, it appeared that the hydraulic propeller as applied to the "Seraing," had a loss of speed of somewhat less than one-tenth. "The 'Seraing' was 130 feet long over all, 13 feet beam, and about 8 feet deep with a draught of water of about 3 feet. The engines are of 40-horse nominal power, with two cylinders of 24 inches diameter and 22 inches stroke, making 50 to 52 revolutions per minute, and working horizontally and direct upon the vertical shaft of a centrifugal pump."

I may mention with regard to this vessel that the drawings of her engines did not come from Mr. Ruthven, and that there is an alteration made in the discharge pipes which Mr. Ruthven objected to. But I am only carrying the history up to the present time. We shall presently see what facts we have arrived at, when Mr. Ruthven had his own way entirely.

Notwithstanding having two veritable vessels to refer to, both of which displayed considerable success, the same opposition was still made to the hydraulic propeller, so that nothing towards its development was done in this country until 1862, when, in consequence of my urgent applications to the Admiralty, an order was given for an experiment to be made to test the hydraulic power, in a gunboat at Devonport. But it will hardly be believed that no one connected with the invention was consulted; and when it was discovered that the experiment was being made, and Mr. Ruthven went down to look at it, he found to his surprise that it was no child of his at all! the invention had been misapplied, and as he would not adopt it, this first Government experiment was unproductive. Well, that was the result of my first application to the Admiralty. But I never ceased my importunities until I obtained permission, in 1864, to have the hydraulic propeller fitted to the "Waterwitch."

I must say that I owe it entirely to the Controller of the Navy that this trial was made in the "Waterwitch." I am certain that if it had not been for him, the trial would not have been made. At that time the aspect of affairs was very cloudy indeed, in consequence of the oppo-

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sition of scientific men, so that the responsibility was far greater to those who recommended the experiment to be tried in the "Waterwitch" then, than it would be to order its application on a larger scale now.

Here is an exact model of the "Waterwitch," not of her fittings, but of her form below the water-line. On seeing that it was a clumsy vessel, and thinking it might be desirable to get more speed, I proposed to take the same draught of water and the same displacement, and I sent up drawings of an iron vessel in which I proposed to put the hydraulic propeller. But it was said, as we are building two other vessels of this class, the "Vixen," and the "Viper," if we put the hydraulic in a vessel exactly like them in all respects, the trial will be so much the more convincing if it turns out that they have equal speed. I saw something in that argument, and of course I agreed to it at once. I was desired, with Mr. Ruthven and Mr. Murray, to prepare an engine for the "Waterwitch," which was done. I speak upon this point, particularly, because it has since been thrown out that the success which has attended this trial is not convincing, because the "Waterwitch" class of vessel is a very clumsy one to drive. I do not consider myself that this has anything to do with it. I think that to get 10 knots with 160-horse power out of such coarse lines, is perhaps more creditable than to get 11 or 12 knots out of a vessel with a finer water-line, a longer vessel, and an easier vessel to drive. That has nothing to do with the question. There is a certain power exerted, and there has been a certain amount of work done; and that is proof of the merits of the hydraulic propeller at the present time. All scientific men can easily make out whether it has succeeded or not. I think it is a very fair trial. If the vessels had been of finer lines, there would have been less work to do, and the same power would have obtained greater speed. I cannot understand why the trial, as it stands between the "Viper" and the "Waterwitch," is not just as fair as if they had been vessels built on faster lines. As a comparative test it is equally conclusive.

The drawings of the engines were prepared by Mr. Ruthven, assisted by Mr. Murray, and by Mr. Dudgeon, who has always lent us every assistance in his power. These are the engines in the "Waterwitch," (see diagram,) only they have three cylinders. I believe Mr. Ruthven rather prefers two; Mr. Dudgeon says he prefers three. It is a question which is best. No doubt, with two cylinders you get less friction, and with three you get more easy motion, but there is greater weight of engine, and I believe Mr. Ruthven still holds to his opinion that two cylinders, in certain circumstances, are better than three.

The results of all these trials are upon the paper in my hand. They are the Admiralty Reports:—on the "Vixen," the "Viper," and the "Waterwitch." It may be sufficient to take the two trials at load water-line of the "Vixen" and the "Waterwitch." They approach nearer in point of draught of water, in fact, they are within an inch and a half—the "Waterwitch" drew nearly two inches more water than the "Vixen" did. The "Vixen" was 10 ft. 5½ in. forward, 11 ft. 5½ in. aft. The "Waterwitch" 10 ft. 10 in. forward, 11 ft. 4 in. aft. The result was.

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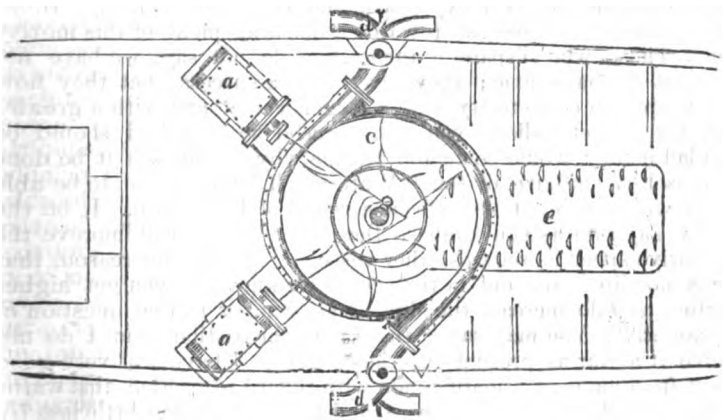
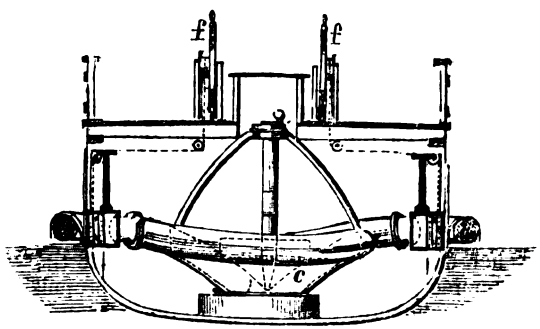
that the speed of the "Vixen" was 8·894, and that of the "Waterwitch," 9·255, more than one-third of a knot in favour of the "Waterwitch." The





mean draught of the "Vixen" was 10 ft. 11 in., the mean draught of the "Waterwitch" was 11 ft. 1 in. The co-efficients were, by the formula for speed and midship section, 317·7 in the "Vixen," and 327·7 in the "Waterwitch." And by the formula for speed and displacement, in the "Vixen" 107·4, in the "Waterwitch" 109·2, both in favour of the "Waterwitch" as by Admiralty showing.

Now, Gentlemen, I believe that every one knows that the essence of the whole affair is in those co-efficients. If the vessels were not exactly alike, the comparison would be no test of the value of the propeller; but where two vessels are exactly alike, midship section, displacement, draught of water, tonnage, the co-efficients certainly do show, if anything will show, the comparative value of the two kinds of propellers.

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Having arrived thus far, I think we have a right to say, that we have facts, and we have a right to ask scientific men to accept those facts, or to give their reasons for not doing so. What I complain of is, that opinions are still expressed, and that unfortunately, those opinions have great weight towards a disparagement of this motive power. Those who disparage the system do not say, we have not done what we have done; they agree it is a success; but they now say, "when you come to try it on a larger vessel and with a greater speed, we do not believe you will succeed so well." I should be very glad if they would come and tell me why. I think if it be done in a vessel of the size of the "Waterwitch," they ought to be able to show why it will not be done in a vessel of larger size. I, on the contrary, say that as you increase the power, so you will improve the comparative speed as regards other vessels. And for this reason, that there is no slip here, and in the screw we know, as you get higher velocities, you do increase the slip. I am coming to that question of slip presently. You may say, "there is water friction," but I do not perceive it as far as present experience goes. I have got very good support from eminent scientific men with regard to friction, that water discharges itself through its centre, and that there is but little loss by friction.

Having given you a sketch of what has been done between the "Vixen" and "Waterwitch," I have no time to go further into it. I shall be very glad to answer any question afterwards.

I now wish to show that these are not the only facts we have got. We have a comparison between what the "Waterwitch" and what two vessels built by Mr. Dudgeon have done. They are vessels of the same type, the "Medusa," and the "Triton." I will show afterwards, as I go along, what Mr. Dudgeon himself says with regard to his vessels. Here are the whole of his calculations, and he here says, guided by his co-efficients and comparisons—(he was on board the "Waterwitch" on all her trials, and he has taken the Admiralty evidence of her diagrams)—"I therefore conclude that about 50 or "60-indicator-horse power was lost in the water propulsion. As com- "pared with the twin screw, it was about one-fifteenth of the power; "and as the twin screw vessel was fitted according to our own system, "the comparison is good." After that, I asked Mr. Dudgeon this ques- "tion: The 'Medusa' and 'Triton' had the same displacement, it is true; "but they drew three feet less water, and they were 30 feet longer. "Are they not an easier class of ships to drive?" Mr. Dudgeon, in his own words at the Society of Naval Architects, acknowledged that it was so; that although the displacement was the same, and the indicated horse-power was the same that was exerted, still drawing three feet less water and being 30 feet longer, they were an easier class of ship to drive, and he considered it quite made up for the loss in the comparative speed of the two vessels.

Therefore, we have substantial facts; but I am sorry to say, they are the only facts at present, unless I mention those connected with the "Nautilus," which vessel I am now about to refer to. This vessel was built at Blackwall by the patentee, Mr. Ruthven, at the expense of

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private gentlemen, for the purpose of practically proving the advantage of the hydraulic mode of propulsion. The hull of this vessel is somewhat similar to that of one of the "Citizen" river steam paddle-boats, being about the same length, although much broader and higher between decks, and fuller in the lines. She is fitted with two steam-engines, each of about ten nominal horse power. The advantages of construction, so far as shape and size of hull are concerned, are on the side of the paddle vessel. Any superiority shown by this experimental vessel may therefore be confidently attributed to the propelling medium. The immense difficulty of inducing the public to attach value to what appeared so novel and extraordinary an invention, induced the owners to incur the expense of building this vessel purposely to prove the correctness of the inventor's calculations and the great value of the principle. Constructed on a model unusually full in the lines, and with no extraordinary power, this vessel may be considered to afford a severe and reliable test. The "Nautilus" having so completely fulfilled this purpose, the owners and patentee have invited the criticism of scientific mechanicians and the public, confident that an inspection of the vessel and ocular demonstration of her performance, cannot fail to prove the great superiority of this mode of propulsion for ships, over any other now in use. But, strange to say, this invitation has not been responded to with cordiality, or with any earnest intention of obtaining information by engineers and ship-builders.

A trial certainly did take place. A "Citizen" steamboat, the "Volunteer," was hired. The Admiralty sent their Officers to witness the trial, and their report of it was, that they went down the river together, they kept pretty even for a certain length of time, when the hydraulic gradually drew a-head and beat her—I forget by how many lengths. One of the Admiralty Officers attached to the Controller's department was on board the "Citizen" boat; and he can testify that they did everything in their power to drive her along, that it was as fair a race as could be. All we then wanted was to get the indicator diagrams of the two vessels. They were very nearly alike. The "Volunteer" had two 12-horse engines. She drew a little more water, had rather a more rising floor and less frictional surface, and therefore had better lines. Indicator diagrams of the "Nautilus," were taken, and we then asked to get the indicator diagrams of the other vessel. They were written for, offered to be paid for, and I am sorry to say without success; we never could obtain them, and we never have obtained them up to this day. Upon that I wrote a challenge in the *Standard* newspaper to any "Citizen" boat on the Thames to a trial with the "Nautilus;" the patentees offered to pay the expense of the trial. I am sorry to say that offer was not accepted. Under those circumstances, I have a right to claim that they were rather afraid of us.

However, I believe that the real cause is this, and it is a natural one to a certain extent:—If this hydraulic principle were to be established, it would set aside an enormous quantity of engineering plant throughout this country, and would probably disturb existing connections. And I have been told since, that if you go into a ship-building yard, and propose

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to make any little difference in whatever is going on, it upsets the order of things; you alter the groove into which they have got, if you begin to introduce anything new. They say, that for these reasons it is evident that novelties create a loss of money; and we cannot therefore expect that engineers, who are making very good fortunes as it is, should be anxious to encourage a new motive power. We must, therefore, push it forward in the best way we can.

Well, then, in due time, as I have said, the "Waterwitch" appeared on the river, and her trials have proved, that to the extent of a vessel of 777 tons, and 160-horse power, the hydraulic has equal merits as a propeller to the screw or paddle. Now, then, comes the point! I am told that official and scientific advisers say that it does not follow that the same success will attend trials on a larger scale with higher rates of speed; in fact, that they express the opinion that it will not. I naturally asked for the grounds of support for this opinion, but that is not obtainable. Now, then, comes the point, the point at which we are stopping now. We ask for a progressive trial. We say to the Admiralty, "you have gone to this great expense of making a trial "when the whole thing was under a cloud, when everybody was in- "clined to speak against it: and, now, that you have got a certain "amount of success, and when you see the enormous advantages, "(which I am going to point out presently), which are likely to accrue "from it, surely you are not going to stop there. Let us have a larger "vessel. This is a 777 ton vessel; you are going to build vessels of "1,200 tons, let us have one to put the hydraulic in, that is all we can "possibly expect, we do not expect to jump at once to the largest class "vessel; although we feel confidence, we do not expect everybody to "have the same confidence." All I ask is to have a progressive trial in a larger vessel and at greater speed. I think a great mistake was made in not building the "Nautilus," to make her the fastest thing to go on the river; if we had got that, we should be in a different position from what we are in now.

On my part, I give reasons, which are I think admissible, for saying that the same results must be obtained in larger vessels. What has been done in the "Waterwitch" is simply this: a certain amount of work has been done for a certain power exerted, and this, when compared with the twin screw in a sister vessel, shows equally good results. Beyond this, in order to test the value of the propeller more completely, and the accuracy of the effective power of the propeller, a series of diagrams were taken at different rates of speed of the engine from 20 revolutions up to 40, and the speed of the vessel due to revolutions being known, it resulted, that the law, "that the power is as the cube of the speed," was fully exemplified. From 20 revolutions right up to 40,—I have got the paper here with the trials, showing the horse-power according to cubes of the speed, and addition for friction and variation, and the result is as I say—it came out, showing exactly, —that power is as the cube of the speed. We took those diagrams for our own information. I merely mention these facts to show that we are not trying to jump at conclusions, but that we have tried to satisfy ourselves by every possible means, and that our opinions are

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worthy of reliance. Surely, it will not be advanced seriously, that if you double the horse-power, it can place this matter on a different footing. If it has been proved with a vessel of 160 horse-power, as it has been, it must act in the same way if you increase the power. It is of no use discussing such points as these, where opinions are allowed to be expressed, and to influence decisions of such grave importance, but where it is refused to submit the evidence to the test of public scientific analysis. I have heard something about friction whispered in my ear. It was yesterday conveyed to me that that was an objection that was raised; that as you get to a larger vessel the friction will be increased; and I have also heard of increase of slip to be overcome. The truth, I believe, is that there is little friction in the discharge of water through a pipe. Water discharges itself through its centre, and if the outer globules are retarded by adhesion to the surface of the pipe; it results in little loss of power to the engine; and even if it were so, to a slight extent, the larger the pipe becomes, the smaller the frictional surface as compared to the increase of the column of water discharged; and, therefore, if it has answered in vessels of the "Waterwitch" size, this supposed loss of power would be reduced as the engine power is increased. But I believe Mr. Ruthven will agree that the loss due to water friction is of very little consideration, if it exists at all. How does water flow through pipes for many miles, with the very slightest fall, with little alteration of speed? Added to that, in the discharge pipe of the "Waterwitch," at the very extremity of the outlet, there is a small flange put inside to retard, as it were, the outer globules, so that they may rest there as a cushion for the discharge of the inner water; and it is done expressly for that purpose. We have been often asked why it is there? People naturally come up and say, "Why don't you get that out of the way? "It is an obstruction." There it is, and we see no reason at present to alter our opinion. I wish I had thought of it, and invited a scientific gentleman who has had a great deal to do with the discharge of water through pipes, and who has written to me, corroborating exactly what I have said. He says, "talking of friction, it is all moonshine, and I "can prove it." And his proof is, that the water discharges itself through a pipe through its centre, and that the frictional loss is proportionately lessened by increasing its velocity or increasing the size of the pipe. Therefore, I think we have a right to dispose of friction altogether, as a reason why we are to do worse in larger vessels. As to slip, I maintain there is none at all.

Well, I will resume the subject of the "Waterwitch" and "Vixen" trials presently, and also show how, by comparison with two other vessels—the "Medusa" and "Triton"—the results have proved equally favourable to the hydraulic propeller, as regards the speed obtained. Having now a right to claim that so far, the hydraulic has, as regards speed, proved its equality to the screw, I wish to put before you in the strongest light I can, the enormous advantages this propeller will introduce in other respects, more especially in war vessels. I have lately read a paper at the Society of Naval Architects which brings to light in a most prominent manner the pro-

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spective advantages of the hydraulic propeller. It is not my intention to read this paper through, but I shall read extracts from it:—

"In all past times one of the greatest merits of a naval architect "has been to produce an easy ship in a sea-way, this being a great "element of sea-worthiness in all vessels, and of efficiency in a war "vessel, as affording a steady platform for the guns. I think the "starting point of uneasy vessels was, when we put the first engines "into a ship of war. From that day, if my recollection carries "me back, we began to find vessels roll more than they did "before. It was a simple cause. The weight of the engine "placed upon the bottom of the ship was a great leverage. How-"ever, that weight might have been counteracted by weights "above, it was a great leverage to make a ship roll when a ship "was set in motion. The deeper the ship, the more it will roll. The "natural conclusion is that if these engines could be lifted that will "dispose of the difficulty. Then, when we added to that, armour "plate to the sides of ships, there was another leverage to make a "ship roll. And when we added to that, bow and stern batteries, "there was another great leverage to make a ship pitch. The over-"hanging weight of the screw with fine lines abaft, is also another "element of pitching. Consequently, we have arrived at such a "state of rolling and pitching that our ships are unserviceable; and I "feel it almost a duty to endeavour by any means in my power to "expose it and to stop it, believing, as I do, that it is quite unneces-"sary and easily avoided.

"If anybody takes the trouble to read the Reports of the Admirals "of the Channel Fleet, I cannot understand how he can sit down for "a day afterwards, and not endeavour to put a stop at once to this "lamentable state of affairs. The reports are by Admiral Yelverton and "Admiral Warden; and the way they talk about these ships and their "rolling is something frightful. Now, I knew of this before. I knew "it must be so, and I have always said it is sure to be so. I have "said, 'You are doing everything you can to make a ship roll;' and "I think, when we hear the reports of the 'Royal Alfred,' the way "she is knocking about, it is really time we began to think of amend-"ing our ways. The 'Achilles' I believe to be a steady ship. It is "something remarkable. I see here, when the 'Caledonia' was "rolling 14 degrees, and the 'Lord Clyde' 10½ degrees, the 'Achilles' "only rolled two degrees. Some of the rolling was 34 degrees and "36 degrees. I cannot explain the cause of this good behaviour on "the part of the 'Achilles,' as I am not aware in what respects she "differs from the other ironclads.

"The greatest defect of our ironclads, then, is their marked pro-"pensity for rolling, but the exceptional case of the 'Achilles' proves "that this defect admits of removal in future vessels. If it is not "removed we must attribute the fact, not to the difficulties of the "problem presented for solution, but to the negligence or incapacity "of the naval architect. It does not appear that arrangements tend-"ing to reduce rolling would in any way interfere with those intended "to secure a high velocity under steam, and in any case it is certain

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"that the efficiency of a fleet depends so much on the steadiness of "the ships as to make it expedient to sacrifice other qualities in order "to secure one of such paramount importance." "Admiral Yelverton "reports that in his opinion a turret ship 'would have had a great "'triumph on this occasion.' The statement will, no doubt, be made "use of by the advocates of the turret system." That is the reason I make use of it here. "The whole tenor of the report confirms in "the strongest manner the adverse opinions which I have always "expressed as regards 'Monitors.' Meanwhile, the turret-ship to "which Admiral Yelverton alluded is as far removed from the "'Monitor' type as anything can well be. He writes, 'For there is "'no doubt that a sea-going turret-ship, say 12 feet or 14 feet out "'of the water, would have fought her guns without the slightest "'difficulty, and fired easily six shots to every one from our broadside "'ship. I do not here allude to the 'Wivern,' for the sea would have "'washed into the ports of her turrets, and swamped everything "'inside.'"

There is one point there. Admiral Yelverton says a vessel of 12 or 14 feet freeboard. Why on earth should the turret-ship not have 12 feet or 14 feet freeboard? Whenever I hear of a turret-ship, I am always told she must have a low freeboard. I never could understand why she should have a low freeboard, except in the imagination of those who wish the sea to come in. I do not see why we should not have a turret-ship with a high freeboard of 12 feet or 14 feet, or even a great deal higher.

Having introduced the subject of rolling, I then go to another feature which this paper, that I read, introduced. It was the immense importance that will be attached in future warfare, to running down vessels, to what we call "ramming." I do not know whether I am wrong, but I can fancy the sort of thing, and I know I should do it to-morrow if I was in the position. All my manœuvres, everything I could undertake to bring my ships into training, would have one object in view, which would be to have the greatest power of "ramming" and running down an enemy's ships. I have heard that one of our Naval Officers has lately written a clever paper upon that subject. I should have been very glad to have seen it, but I am sure I go heartily with it. Who on earth will stop popping away with his guns, when he can go "bang" at the enemy and sink him by one blow, if you hit him with the spur. But a screw vessel can only strike with one end, the bow, whilst one with the hydraulic propeller can strike with equal force with both ends, and therefore the ramming power is doubled—a most important feature. With reference to this point, I will tell you what was done the other day in the "Nautilus," before 24 witnesses, going ten knots an hour. We dropped a piece of wood over the bow, and the ship was stopped, dead, in half her own length, when the piece of wood was on her beam. And in ramming, if I see that I am likely to miss with one end of the ship, I can stop, and can go at full speed in the other direction, and I am sure to hit something in a *melée*. If, however, I have to turn a long ship like the "Achilles," my ramming power is very much restricted; therefore, I introduce

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ramming as one of the greatest advantages connected with this hydraulic propeller. I have a rudder at both ends, but I do not care about the rudder, because I can steer without it perfectly well. But I have a rudder at both ends, and my principle in gun-boats is to fight with my stern towards the enemy, on the end-on principle. I will explain that presently. I will keep to the point I am talking of, viz., ramming, and I say that the hydraulic power alone, secures this perfect system of ramming. It also gives you a great increase of turning power, which is another element of ramming, for you can reverse the bow of your ship without turning at all, or move either end of your ship in the direction in which you wish to go, without making a circle.

I will now read what introduces the advantages of the hydraulic. At page 6 I mention, "At present I really believe that a gale of "wind would almost cause as much damage to the fleet as a naval "action." Now, I have heard a good deal about the fate of the "Royal Alfred" going out the other day. What I have said is, if one of these vessels should get caught in a heavy gale, and if from some accident to her engine she cannot use it, she will roll away her masts, and when she has rolled away her masts, I do not know what will become of her hull with the present momentum they have. The other day, with her engine intact, the "Royal Alfred" carried away her main yard; she started away her chain plates, and very nearly lost her mainmast. What would have become of her if her engines had stopped? We have never had an instance of that. I have had engines stop in the old "James Watt," in gales of wind, unfortunately, at the wrong time. If one of these ships got into heavy weather, and her engines were to be disabled, I think she would be very soon dismasted; I do not think canvas or anything would stand that great rolling. If she carried away her sails she would roll more, and would carry away her masts; and if she carried away her masts, she would perhaps lose her hull. We have never had a ship in that predicament; but we have the evidence of Naval Officers who have seen how ships roll, who tell us that it is time to go back to those old times when the great object of the naval architect was to make a good sea-boat, that is, an easy ship at sea. It is due to Officers and men, as they have to contend against heavy weather and hardships of every kind, that they should have confidence, that everything is done in the vessel they belong to, to make her as seaworthy as it is possible to make her.

I know the great difficulty of regulating weights so as to secure easy motion. In a deep ship the engines are low, and the leverage therefore great, and the armour belt is below the water line, but the whole weight of armour and guns has been placed on the sides of the vessel, with great weights placed in the extreme bow and stern, and thus all the elements of uneasy motion have been intensified, so that no amount of skilful designing could produce an easy ship.

I am very curious to know how the "Achilles" is so easy a ship as she is; there is no doubt of it, I believe.

I do, however, maintain that we have neglected to a great extent the importance of adopting all remedial measures to reduce, as far as possible, the causes of violent and extensive rolling and pitching. The

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great object to be attained, to procure easy motion, is to concentrate as much as possible all weights, not only vertically towards the water line, but also from the sides to the central line, and also from the bow and stern towards the centre. The broadside principle is antagonistic to this. The bow and stern batteries are a part of this broadside principle, and are fatal to the sea-going qualities of a ship, therefore, the neglect of taking advantage of the turret principle has been a great mistake. To raise the weight of the engine considerably towards the water-line, and to get rid of the great weight at the stern, which the screw propeller necesitates, would remove all difficulty from the work of a naval architect. I am glad to say that this advantage is now within his reach by the adoption of the hydraulic propeller.

There is no reason whatever why the hydraulic propeller should not be placed near the water-line, if you like, engines and all; not one single reason. In fact, I believe it is the best place. If the water is coming in through the canal under the bottom of the ship, the more that canal rises to the engine the easier the access of the water to it. And you may raise the whole weight of the engine to the water-line, and in that way it is a mere matter of cargo, you can place it where-ever you like. But I would prefer the nozzles to be sufficiently low down, not to roll out of water, and to be out of the way of exposure to shot. And yet we hesitate with such advantages within our grasp! There is far more to be gained than that by this new propeller; yet it appears, that like the turret-principle, it might have to stem the tide of prejudice for a lengthened period, except that I have great faith in the clear-sightedness and impartiality of the present Board of Admiralty. I have mentioned the hydraulic propeller as affording the means of facilitating, to almost any extent, the most advantageous distribution of weights, by raising the engines to any height required, and by dispensing with the great over-hanging stern-weights required by the screw-propeller. I would also call attention to another important advantage of the hydraulic, as contributing towards a steady platform. The turbine itself is a central weight, and from the great centrifugal force exerted, it will produce a certain amount of counteracting power to the rolling of a ship. You are discharging, I think, 350 tons of water in a minute in the "Waterwitch," from the turbine, and that is a great centrifugal force, acting as a steadiment to the ship.

It really is a most serious defect, that our present ships should roll about, as they do, especially when sails are furled; and what an unfortunate effect it would have upon the efficiency of a fleet when moving about in action, regardless of the direction of the swell. In heavy weather, I really do not believe that any spar or sails would stand the test of such heavy rolling; and if that means of steadiment were gone, there is nothing for it but to bow the sea with steam power. If that fails and the dismasted hull is left to its own momentum—such a case was bad enough in olden times—but what would it be now? and naval actions generally leave ships dismasted. Surely, then we should grasp at every means of so regulating the weights, that the easiest motion may be secured. The hydraulic, in this respect, will prove your best friend.

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In many other ways ought this principle also to command the attention of naval architects. If the water be discharged above the water-line, the impediment to the speed of a ship, under sail, will be very slight, as compared with that caused by the screw, which, if not raised, is always a drag in the water, in addition to its retarding effect by increasing the sending and pitching of a ship in a sea-way. As the hydraulic has now proved itself equal to the screw at the *measured mile* by the speed obtained for the same power in similar vessels, it must be placed at great advantage, in a sea-way, when a ship is pitching, and the screw is making repeated visits into the air, because whatever the ship may be doing in the way of pitching, the hydraulic power is always the same; whereas, whilst the screw is out of the water, of course its power is entirely lost; and the steam that is being used to make those revolutions in the air, causes a dead loss of fuel. Therefore, in a long voyage, I look upon it that the hydraulic must prove, as against the screw, a very great source of economy. Let any one get on to one of our headlands, and see a screw-steamer trying to get round, with a foul wind; he will see the screw as much out of the water as it is in. Here is a great loss of fuel; a loss of speed; a great strain on the ship and engine; and, by prolonging the voyage, another cause of loss of money.

Another source of economy which the hydraulic provides, is when steaming and sailing. The speed of the screw must approach the speed obtained by the sails, before it acts as an auxiliary, and the steam which is expended in reaching that speed of engine, represents a dead loss of fuel. But the hydraulic propeller, when acting as an auxiliary to the sails, developes its whole steam power as an additional force; therefore, this must produce a great saving of fuel.

When the screw is superseded—as I feel convinced it will be—the naval architect will rejoice to find himself unembarrassed in designing a sailing ship, both as to the form of vessel, and as to the position of weights; and I believe that the nation at large may rejoice to see in the dawn of this new motive power, a revival of her maritime superiority, because it admits of a return to a more perfect construction of sailing vessels, and when good seamen will again become an essential feature of the strength of our sea-girt isles. Again, the hydraulic propeller causes no vibration, so that a great cause of discomfort is removed, and the weight and expense of strengthening a vessel to withstand the vibration of the screw, is avoided. Again, the hydraulic propeller will prove itself most valuable in reducing the danger of collision, as the officer in charge of the deck will have the power of stopping the ship in twice or thrice her own length from full speed, by reversing the nozzle-valves; and this power is under his immediate command on deck, without any orders to the engine-room. The handles to turn the nozzles are brought up to where the bridge is (see f.f. fig. 2); in fact, where there is sure to be somebody, who, at the word "Stop her!" would have nothing to do but to turn the nozzles round; and there is at once the whole power exerted to make the ship go astern. I have said, "in twice or thrice her own length," because, although the "Nautilus" stopped in half her own length, she is a very light

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vessel. Many a man's life and much valuable property would be saved by this facility of not only stopping, but of returning to the spot where the man fell, without turning the vessel round. Having a rudder at both ends you can steer right up to the man; and I believe you would pick up a man quicker by the vessel than you would by lowering a boat. In fact, I have tried it with a piece of wood, and we could have picked it up in a shorter time with the ship than by lowering a boat. I consider that all new vessels with the hydraulic propeller will be shaped alike at both ends, and thus obtain equal speed both ways. This feature is invaluable to war ships by doubling the destructive power of ramming, which, I am convinced, will become the great element of sea-fighting. Having a ship, shaped alike at both ends, will be acknowledged, I believe, by everybody to be no detriment to speed, nor any objection as regards sailing or sea-going qualities.

To exemplify what I have said, I will give an instance of what has occurred quite lately. A vessel called the "Mary," whilst in the act of sounding, found herself in shoal water, on the edge of a bank. Owing to the orders, conveyed to the engine-room, having been mistaken, she was carried further on, and, before the mistake was rectified, she struck the bank heavily two or three times, abaft, and the first time she struck, the starboard screw and end of shaft broke off and disappeared at once. The vessel had no other damage done to her hull. The "Mary" was the property of the Messrs. Dudgeon. Now, with the hydraulic propeller, nothing of this kind would have occurred, as no orders are required to the engine-room, the directing power of the engines being under immediate control on deck; and in case of a ship striking the ground, whilst the screw is always subject to damage, the hydraulic is safe.

Again, the hydraulic engine, acting as an enormous pump, will discharge from the hold upwards of two tons a minute per nominal horse power; so that with an engine of 500-horse power nominal, 1,000 tons of water a minute would be discharged in case of shot-holes, or a leak, admitting the water, and there is no possibility of choking so large a discharge-pipe. If the holes were large enough for a man to come in with the water, he would be carried right through, and go out at the discharge-pipe; and I look upon it as a most important feature, that by merely closing the sluices, you can then discharge the water from the ship itself.

Again—(you will think I am never going to end with my advantages of the hydraulic propeller)—the hydraulic propeller can never be *fouled*, whilst the screw is easily disabled by floating obstructions in the water, as the nozzle can be protected by a shield, or placed under water out of harm's way; in action the motive power would be always safe, whilst the screw and sternpost must be, to a certain extent, exposed. I see that Admiral Yelverton remarks upon that; he says, he thinks he must be a very bad gunner who would not knock away the rudder of the "Bellerophon." when she is pitching, at the first shot. He mentions this in his Report to the Admiralty.

Now, on the question of speed, and as proof of the success of the hydraulic propeller, I am justified from letters I have received from

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Mr. Dudgeon, and from the Admiralty reports of the trials of the "Waterwitch," in stating that substantial evidence on this point has been obtained. It is true, Mr. Dudgeon constructed the engine of the "Waterwitch," but he is known as the special friend, and the most successful designer of twin-screw vessels, and I believe his vessels have equalled the best speed of the single screw or paddle. And I consider it most fortunate to have obtained the advantage of his ability and generous support in developing this new motive power, knowing that his opinion is devoid of all prejudice.

I wish to call special attention to the fact, that the naval architect must have greater command of speed with the hydraulic propeller than with the screw, because the screw is always limited as to diameter, and supposing unlimited power be given to a screw-engine, as you increase the number of revolutions, the resistance is increased on the bows of the vessel, until the loss by slip gradually increases, and so you arrive at last at a point when the screw is making all slip.

But the turbine has no slip, and you may have several turbines in one vessel; and to whatever extent you increase the boiler power, so you increase the speed, under the law that the power is as the cube of the speed. So, if you wanted to go 20 or 30 knots an hour, the only possible way of attaining it is, by the turbine, because you cannot increase the diameter of the screw, nor can you multiply them; you may increase the power of the engine, but, when you get up to a certain point, the power would be so great, that the screw would be all slip.

The battle between the turret and the broadside principles has been always fought on the merits of gunnery questions alone, but there has been another very important question at issue, and that is, as to the most advantageous distribution of weights; and now the hydraulic propeller presents the same consideration as compared with the screw, only to a much larger extent. The turret principle and the hydraulic propeller, when combined, will solve all difficulties attending the creation of an armour-clad ocean fleet of the line: and I do earnestly hope that before another large vessel is laid down, a total change may take place as to the sea-going qualities our ships are to possess for the future.

For an hydraulic gun-boat, I recommend the *end-on* principle of fighting, as of old, with a heavy gun behind a stout shield, and no attempt of broadside armour protection; the bow rendered unsinkable, before the shield, by partitions filled with cork, to the level of the water-line. I merely mention this because the model on the table happens to represent this principle, and it is what I suggested should be applied to the "Waterwitch." Then, by keeping the stern of the vessel on, towards the enemy, I could always retreat without turning round. My opinion is, that the end-on principle of fighting is a necessity for gun-boats, and that such a gun-boat would prove most mischievous against large vessels for coast defence. That is to say, with that heavy gun, and that thick defensive armour-plated shield, and with the bow protected in that secure manner, I could, with one of these gun-boats, in shoal water, drive off any armour-clad; nor do I think an enemy would

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run the risk of exposing so large a vessel to destruction by a small gunboat of such a character. I think, myself, that that character of gunboat will become a very formidable weapon for the defence of our coasts. I am sorry they would not allow me to fit the "Waterwitch" in that way, but the day will come.

In one respect, particularly, I hope that I may be in error, but judging from the reports of Officers in whose opinion I have great confidence, I really do not believe, that, with the exception of the two first that were built, the "Warrior" and "Black Prince," and perhaps the "Achilles," we have an iron-clad in our Navy which could be safely trusted, if placed in the middle of the Atlantic in the winter time, were she to break a screw shaft, and if heavy gales and continual bad weather were to come on. Another thing is, that in action, vessels get their masts knocked away, and then with the screw shaft disabled, they would be at the mercy of the waves, and I really do not know what would become of them.

Some of my remarks may bear the stamp of unsupported doubts and fears, but I am willing to bear the burden of this accusation, and shall be quite content to do so, provided what I have said may have the effect of producing a greater degree of consideration in the future of armour-clad designing, to the matter of the safety of our ships at sea, and to the classification of ships.

I would just refer to what was said by Mr. Reed with regard to my paper, as regards the "Waterwitch." He says:—"With reference to "the hydraulic system, he should be very sorry if what he said should "be construed into an opposition to that system, because it was very "undesirable that a system which had started so well as that had "started, should encounter any prejudiced opposition. In the first "place he thought the twin-screw vessels—he did not mean "Mr. Dudgeon's, for he had not the pleasure of seeing them—with "which the 'Waterwitch' had competed were about the most "wretched specimens of vessels as regards propulsion, that could "possibly be produced." I am sorry Mr. Reed should have said that. First of all he built them himself; and, independently of that, I do not know that that has anything to do with the trial of the two motive powers. He says:—"The 'Vixen' and 'Viper' were little more than "shallow floating boxes, very heavily burdened with armour plating, "of very light draught of water, and with very full bows and sterns, "and he might say that they had the double stern chiefly on the "ground that it gave them more displacement. The 'Waterwitch,' "as compared with those vessels, had this advantage, that whereas "they trimmed afoot by the stern, the 'Waterwitch' had the same "maximum draught, an even keel, which had the effect of enabling "them to fine the lines a little. It could hardly be admitted that a com-"parison between the principle of the 'Waterwitch' and the screw "principle was sufficiently established by the competition between her "and such vessels as the 'Vixen' and the 'Viper.' At any rate the "'Waterwitch' did better than they looked for, and no one could fail "to appreciate many of Admiral Elliot's suggestions as to the advan-"tage of the hydraulic system as compared with the screw." I merely

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mention what Mr. Reed says to show that, generally speaking, he rather conveys the impression that the "Waterwitch" was a success.

My reply to what he said was as follows:—"Mr. Reed had endeavoured to show that the trial of the 'Waterwitch' was not trustworthy evidence of success, becuse the 'Vixen' and 'Viper' were, in his opinion, 'the most wretched specimens of vessels as regards propulsion that could possibly be produced, and because the 'Waterwitch,' although a sister vessel, had both ends shaped alike, and was of the same maximum draught, but on an even keel, which had enabled them to fine the lines a little.' Now he (Admiral Elliot) would put it to the naval architects present, whether, as the vessels were of the same type, it was not as fair a comparative test of the propellers to do the same work, for the same power exerted in coarse lined ships, as in those of finer lines? And also he would ask whether it was possible to obtain finer lines in the 'Waterwitch' than in the other vessels, with the same length and breadth, and same midship section, and greater displacement, and the same maximum draught of water? Comparing the lines of the two vessels, it became evident that the 'Waterwitch" was at a disadvantage in point of form to the 'Vixen' and 'Viper,' and a very clever naval architect had given a decided opinion that it was so." Then, with regard to Mr. Dudgeon, I asked, "Whether, considering that his vessels, the 'Medusa' and 'Triton' were 34 feet longer and 3 feet less draught of water than the 'Waterwitch,' and therefore easier driven vessels, although of the same type and the same displacement, he did not consider that the hydraulic propeller had shown equal merits to his twin screw principle by comparison of results of speed?" Mr. Dudgeon assented to it.

I will merely mention these remarks of Mr. Scott Russell:—"He was not known as an advocate of that principle. He had known of it for two generations, and as far as he knew the relative value of propellers it stood thus:—That the paddle-wheel, the double-screw, and the hydraulic propeller were, theoretically, equally good. Out of them all they could get the same speed, and it was a mere matter of human ingenuity, in which he had infinite faith, applying each propeller so as to get out of it the special qualities and the speeds required. He would undertake to say that a hydraulic propeller, a double-screw propeller, and a paddle-wheel with the same power of engine, would all give the same speed, but under very different circumstances, with very different combinations, and with very different elements of construction. Therefore, he would say to Admiral Elliot, 'Go on, feel your way, puzzle your brains, get as many 'clever men to work as you can, and go on with your hydraulic propeller, and I promise you in the end, that you will certainly 'succeed.' I do not say that you will ever get more speed than you will out of the others, I will not say it will not take you a long time to get the same speed as the others—I won't say that you have not a deal of trouble still to take, and a monstrous quantity of ingenuity still to throw into it before you can get your wheels conveniently placed, and before you can get your large orifices for a

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"ship of large size so constructed that your machinery shall work "handily, but I promise you, if you go on you will get it."

I have only a few words more in conclusion; I must apologise for the incompleteness of my preparations for reading this paper, but I trust I have laid before you sufficient evidence of the importance of this subject to secure from you an interest in its early development. At present the fate of this invention is in the hands of the Admiralty; they, having in its earlier stages, when all was dark and suspicious, considered it of sufficient importance to make so costly an experiment as the "Waterwitch." I do trust that now so much success has attended this first trial in a war vessel, they will not delay in making a further trial in a larger vessel, with greater power, intended for high velocity. I ask for one of the new corvettes of the "Blanche" class, 1200 tons and 350-horse power. This would be a most satisfactory trial, and four of those vessels are to be built this year. I wait in hopes of a favourable reply to my request.

The CHAIRMAN: This is a subject that interests us all very much, and I have no doubt there are many gentlemen here who will be glad to give an opinion upon it. I will ask Admiral Elliot to take a note of the various points that may be raised, so as to enlighten us as to the merit of the objections that may be made. For myself I would wish to ask him two questions: One is whether the discharge of the water from a turbine, if under water, would not give a greater power of propulsion than if it were at the water's edge and exposed, as having a greater resisting medium to act against? Next, when he spoke of the ramming, how far we should be able to have a solid fabric, with rudders, at the two extremities of the ship, capable of ramming an enemy satisfactorily, either one end or the other? If we can do that, it would be a very great advantage. But the rudder, I think, would be rather antagonistic to the solidity of the two ends. Those are the only two points I would like to ask him about.

Captain C. H. SIMPSON, R.N.: I would like to ask one question. Admiral Elliot has stated that there is no slip on the hydraulic principle. I always had an idea that the slip was the velocity of a propeller over that of the vessel. In the hydraulic propeller the water is the propeller. I would wish to ask if the water issues from the tube or nozzles with greater velocity than the vessel moves? and if it is necessary that it should do so? Because if it moves at greater velocity, it appears to me that the excess of velocity of water over the velocity of the ship must be the slip. I would also like to ask why there is this extraordinary power displayed in the hydraulic principle in stopping suddenly? I wish to ask what is the cause of that power? It is a special thing belonging to the hydraulic, and, therefore, must have a special cause. My object in asking that question is, because I think that the same cause that gives that power to the hydraulic, is the very cause that will, at high speeds, make it inferior to other propellers.

Admiral Sir JAMES HOPE: How do you propose to protect the propeller?

Admiral ELLIOTT: With a shield.

Sir JAMES HOPE: Is there any position for these propellers which would be more advantageous than another for speed?

Admiral ELLIOT: We think the propeller just above water is the best position. We tried it in the "Waterwitch" first of all, with the nozzle out of water; then we sunk the vessel down, and tried it with the nozzle in the water, completely immersed; and having compared the speed at light draught and at deep draught, as against the speed of the "Vixen" at the two draughts, we found, as far as we could ascertain, it did not matter at all. But the reason we think it better to have the nozzle just above the water is, that the freer the discharge of water, the better for the re-actionary power by which you obtain your speed to go ahead. If you dis-

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charge your water into a vacuum, by comparison, you will get the greatest advantage from it. Therefore, if water, by being discharged against water, is retarded, we think it is rather a hindrance. If you close the mouth altogether, no action will take place; if you open it slightly, a small action is obtained, and small speed; the freer it goes out the better. But we do not believe that there is anything so important in it but that it can be put down under water.

Commander COLOMB, R.N.: It is rather late, but I should like to make one or two remarks. Admiral Elliot somewhat disparaged the Devonport experiments, and said they were not fathered by the inventor. That is perfectly true. But at the same time, the Devonport experiments were sufficient to show the value of the mode of propulsion in a certain degree, and I believe gave a very considerable push to the invention at the Admiralty. The experiments were tried in a gun-boat of 60 horse-power, the "Fan," which expelled the water driven by the ordinary engines of the ship. The velocity of discharge from the pipe was 2,190 feet per minute, and the loss, which would be actual slip, or friction, or whatever you call it, was 205 feet per minute. The dynamic pressure, at that number of revolutions, with an indicated horse-power of 173, was 1,442 lb. It was found, and this may be an answer to the Chairman's question to a certain extent, that the dynamic pressure increased from 150 lb. to 200 lb. when the nozzle was placed below the water. I am not going to attempt to explain why it should be; I cannot see myself why it should be. Though there appears to be from these experiments some slight friction, yet I believe that it is wrong altogether to look at the question as involving friction, because the power in this mode of propulsion is given by pressure; and the only way to understand it, I believe, is to consider it as a pressure, and as a release of pressure. The travel of the fan of the pump is sufficiently great to generate a certain pressure in the pipe leading to the outside of the ship. Now, pressure on all sides of that pipe is equal, necessarily. You open a portion of the pipe, and you take off that, by opening, the pressure which previously existed there, and you have, as the remainder, the pressure upon the part which is opposite to it; and that is how you get your power. If you take friction into account, I think you immediately get into a maze of difficulties from which I see no possible exit. Admiral Elliot made a great many remarks about rolling. I cannot say I know very much about the subject, still I have looked a little into it, and I have had the opportunity of witnessing a practical contradiction to some remarks which the gallant Admiral made. He said that he thought rolling came in with the steam-engine. Now, I have served in a great many ships, but the heaviest roller I ever served in, without exception, or ever expect to serve in, was a Symondite brig. The gallant Admiral also expressed it, as a certainty almost, that the placing the weights at the extreme of the beam, as they are placed now, with heavy guns and iron-plating, necessarily increased whatever rolling powers the ship might previously have had. The other night I quoted here some experiments of Admiral Paris. He tried very accurate experiments in a small vessel, and he found that as he placed the weights towards the extreme of the beam, so the rolling of that vessel decreased. I do not believe that the rolling of our ships has very materially increased, except in the case of wooden ships of the "Caledonia," "Royal Alfred," "Royal Oak" class. In the case of the "Warrior," I happened to be present during her first official trial, and I recollect that her rolling power, as compared with that of the "Revenge," which was a very steady ship, was only 20 degrees to 17 degrees. But I am inclined to demur altogether to the records of the rolling of our ships. I am inclined to demur to them, because we have never had any proper instruments for measuring the rolls. On board the ship I was in in the Channel Fleet, we tried from time to time to get at the ideas of different Officers as to the rolling of the ship at particular times, and we found that those ideas varied immensely. I am very glad indeed to get another confirmation of my idea that the ram is to be our future weapon; and in corroboration of what Admiral Elliot has spoken of as regards the necessity of arming the stern for ramming, as well as the bow, I may say that the Russian Admiral, Boutakov, has pointed out in his work on naval tactics the great necessity for this. It is a point he has urged very strongly, and I agree with him; and I agree with Admiral Elliot also that it is a most important matter. I have only one word to say about another advantage of the hydraulic which

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I did not gather, that Admiral Elliot brought forward. I look upon it that the hydraulic propeller will enable us to increase the beam of ships, and thereby reduce their length, while at the same time retaining their mass. That is, we may increase the lateral area of the midship section, while we take off from the vertical one, and thereby we shall get a handier ship, at a lighter draught of water, to do the work which is now done by a longer ship, with a narrow and deep midship section.

Captain RICHARD WELLS, R.N.: I should like to ask whether the space taken up by the engine-room, the turbine-wheel, and the well for receiving the water, is greater in vessels of a similar class than the space taken up by the engine-room and the machinery in an ordinary screw?

Commander POLAND, R.N.: In the case of getting on shore, I should fancy the power of the turbine will be entirely destroyed, or nearly so, should the vessel land on sand, which would fill up the holes in the bottom.

Admiral ELLIOT: The first question, I think, was with regard to the discharge of the water above the water-line and below the water-line—whether it was an advantage? I think that was the question that was put. I have just described it to Admiral Sir James Hope that it is a question which is undecided; there are different opinions upon it. An eminent French engineer makes it out that it is better under water; that increased power and increased speed will be obtained. Mr. Ruthven thinks the contrary; but as regards the effect of rolling motion, it will probably be better that the discharge-pipes should be so low down as not to roll out of water. But it is a question not decided. The next question was with regard to the weakness of a double-ended vessel, in consequence of the rudder. I think if the end is shaped so that the blow is struck here (pointing), if that is backed by the vessel, particularly where the deck is, that if the blow is struck there, I do not think you will weaken it by having the rudder here. I think the rudder may be lower down than this is. This rudder has a much larger surface than the ordinary rudder of a ship. But you may lower the rudder and take a piece off the top, and you will still have sufficient surface for steering. I think that that weakness may be reduced. I do not think it will signify; it is a question for the naval architect to arrange. But I do think you will be able to have a perfect ram at both ends, and have a rudder underneath; by building it for the purpose. I should say that, in the case of ramming, we have seen enough of it to know, that this piece the spur should not be a part of the vessel at all, but that it should be capable of being taken off, leaving the vessel intact afterwards, not to open the vessel out if you lose your spur. The next question was with regard to the power of stopping the hydraulic, as compared with the screw. I could not quite understand that question. The whole power of the engine is immediately applied, in almost a second or a few seconds, to stop and to go astern. You merely reverse the nozzle valve, which is like a tap in a beer cask, and the water, instead of flowing out in one direction, flows out in the other, so that the whole force is exerted to drive the ship the other way. If you could instantaneously reverse the paddle-wheel you might get the same power there, but you cannot do that suddenly. It is quite the reverse with the screw. When you come to stop a ship going ten knots, and to turn your screw astern, in the first place it is a long operation. It is a great strain upon your engines; and if you look to the shape of the screw, and the effect it has, you would find that if you were to go as fast as you could astern, you would produce little effect. You might go 14 knots ahead, but I question whether your ship would go 4 or 5 knots astern; and certainly you cannot steer, because directly you come to back with the screw, the ship's bow is sure to go (according as it is a right-handed or a left-handed screw) in the opposite direction. I found in narrow channels I could not use the screw astern. Directly I did, it threw my bow round, and it would have put me right ashore. I remember also in the Baltic a ship attempted to back with her screw, to keep astern of the Admiral, and she run her bow right into the flag-ship's quarter.

Captain SIMPSON: Then the paddle would have the same power in stopping as the hydraulic?

Admiral ELLIOT: I think it depends upon how the paddle floats are placed for going ahead. If they are vertical, of course they would have the same power; but you would still have to disconnect, reverse your wheels, and that is a long operation.

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Captain SIMPSON: Reverse the engines?

Admiral ELLIOT: Reverse the engines. You have a certain amount of machinery to set in motion. The next question, I think, was with regard to the slip, whether the water was discharged quicker than the ship goes. The water in the "Waterwitch" is discharged at about double the speed the ship is going, whatever the speed of the vessel may be. But there is no slip; and the best proof of it is that you obtain the same result with the same power.

Captain SIMPSON: But if the water is the propeller, and the propeller is going with greater velocity than the vessel, surely the excess of the velocity of the propeller over that of the vessel, is slip?

Admiral ELLIOT: There is no such thing as slip nor loss of power, as supposed by Captain Simpson. The power is obtained by reaction from the water discharged. Whatever the speed of the ship, it does not lessen the effect of the reaction due to the amount of pressure produced in the discharge pipe. By way of comparison, if a ship were going 50 miles an hour, and you fire a gun right astern, the speed of the ship does not lessen the recoil of the gun. Nor does it lessen the recoil, or rather the reaction produced by the discharge of water from the discharge pipes.

The Devonport experiment I should like to refer to. What I said was, that the experiment was made without any reference to the patentees. No question was ever asked of the patentees, as to how that experiment should be carried out, but I can assure my good friend Captain Colomb, that his information to-day is the first information I ever received, either by word of mouth, or by letter, as to what the result of that experiment was. I was never told. I did not know whether it was successful, or whether it was the reverse. It was kept very secret. You have let out a great secret, and I am glad to hear the experiment had such a good result. There was no report made to me; and as I said, Mr. Ruthven went down, and seeing it was no child of his, he abandoned it. But I think that when the Admiralty ordered the experiment to be made, we might have been consulted as to the mode of making it. A question I should like to answer is, with regard to the rolling of the Symondite brig. I could understand the Symondite brig rolling. I have been in a Symondite brig myself, and I should like to ask a counter-question to that, which is, "Did you ever go in a Symondite after she had an engine in?" because, I think if you did, you would find she rolled a great deal more. We have only to take the "Colossus," and vessels of that class, in which an engine was put, and it was acknowledged that they rolled a great deal more afterwards. I think that speaks for itself, that it is the weight of the engine that causes the rolling. Then, with regard to the spreading weights out to the side, having stopped the rolling. I expect if we had analysed that, we should find that the weights that were put to the side, was ballast that was "winged" up. I know that in many instances where they "winged" up ballast in Symondite ships, they found it reduced the rolling. But it was not because the ballast was "winged" up that it reduced the rolling; but it was because you raised the centre of gravity, and that reduced the rolling.

Captain COLOMB: The balance was on the same level, throughout.

Admiral ELLIOT: I go upon the broad principle that centralised weights decrease the leverage and reduce the rolling, *cæteris paribus*. Then with regard to the question of increasing the beam in an hydraulic vessel, I do not see that the hydraulic facilitates the increase of the beam, but it does the reduction of the draught of water. I think in a light-draught-of-water vessel, you can get greater speed than with the screw; as you decrease the draught of water, you injure the power of the screw. With regard to that, the turbine need not be under water. If the bottom of the turbine is in the water, the moment you set it in motion you cause a vacuum, and the pressure outside will fill it up. Therefore, in very light draught of water, you can get great velocity, whereas you cannot do so by any screw. Mr. Dudgeon, in his recommendations to the Brazilian Government, speaks of that. He says, if you want great speed in a light-draught-of-water vessel, I must take the turbine for it. With regard to a question as to the relative spaces required for the hydraulic engines and those for the screw machinery in vessels of the same class, the "Waterwitch" engine is placed in exactly the same space as the engine of the "Vixen" and "Viper." When I found that the screw passage was available, was

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a space that I was going to lose, I asked for that same area to be given into the engine-room. It is added to the stoke-hole, not to the engine-room. The engine is exactly in the same place. But if you go and measure the stoke-hole, you will find there is a very fine stoke-hole, adding a couple of feet for the stokers. But the principle is weight for weight, space for space, price for price, and speed for speed. Now, there is another question that I am very glad has been asked me, about getting on shore. I would not speak of it, because I thought it might be put. We must first of all ask, what do we go on shore upon? If we go on shore on rocks, I do not think anybody will say that the water will not come in. But as the canal of the turbine forms a double bottom, and as there are additional kelsons, the strongest part of the ship is, where the canal is. If we go on shore on mud, we know quite well, that if you put the hydraulic vessel on mud, you can work your engine; it is mud and water that comes through, and you can soon work a hole under the vessel—there is nothing to stop it. Sand would do the same thing. We hear of getting vessels off now, by stirring up the sand below, and pumping it out of the vessel. Here is a turbine that will do it for you. If you make a hole under the ship on a sand bank, the sand will crumble in; but I think this turbine will some day be found to get a vessel so circumstanced off. If you put your vessel on stiff clay, perhaps you could not stir that clay, but there is generally ooze on the top of the clay. But supposing there is any objection to the canal being under the bottom of the vessel, we could just as well, instead of letting water up into the turbine by the canal from below, let it into the turbine from the side. What we asked to do the other day with a wooden ship was to put it there. There is no reason in the world why you should not open the side, and make the canal on each side of the vessel. I think that I have now answered all the questions.

Captain INGRAM, R.N.: Could you drive your ship through a heavy head sea?

Admiral ELLIOT: I think that question was answered just now, that so far as the turbine is concerned, the power is always the same.

Captain INGRAM: Would the head sea check you sooner than it would check the screw?

Admiral ELLIOT: I should say, certainly not, because the screw is out of the water, and you lose a portion of your power; but with the turbine the same power is always being exerted.

The CHAIRMAN: I am loth to stop any further questions, but the hour is very far advanced, and I think we are prepared now to close the discussion. We have all had an opportunity of speaking; but I think there is one thing that all agree upon, whether we think the plan is successful or not, that is, that we must be very grateful to Admiral Elliot for bringing it forward, and for the way in which he has put the various facts before us. I must say, there is much to learn; I, at least, have learned a great deal myself, and I hope we have all learned much from the paper. Even the remarks that have been made, have elicited what is very valuable. As I said before, we are all very much indebted to Admiral Elliot for his admirable paper.

Admiral ELLIOT: I have only to return my grateful thanks for the patient manner in which you have heard what I have had to say.

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LECTURE.

Friday, June 28th, 1867.

COLONEL PHILIP J. YORKE, F.R.S., in the Chair.

PRIMITIVE WARFARE: ILLUSTRATED BY SPECIMENS FROM THE MUSEUM OF THE INSTITUTION.

By Colonel A. LANE FOX, Grenadier Guards.

ALTHOUGH it is more in accordance with the purposes for which this establishment has been organised, that the Lecture-room should be devoted chiefly to subjects of practical utility connected with the improvement of our military system and the progress of the mechanical appliances, the organization, and general efficiency of our Army and Navy, than to the efforts of abstract science, yet the fact of your possessing in the three large apartments that are devoted to your armoury, one of the best assortments of semi-civilized and savage weapons that are to be found in this country, or, perhaps, in any part of the world, is sufficient to prove that it is not foreign to the objects of the Institution that the science of war should be ethnographically and archæologically, as well as practically, treated.

The requirements of our advancing age demand that every vein of knowledge should be opened out, and, in order to make good our title to so interesting a collection of objects as that comprised in, what may very properly be called our ethnographical military department, it should be shown that, whether or not the subject may be considered to fall within the ordinary functions of the Society, our Museum is made available for the purposes of science.

The age in which we live is not more remarkable for its rapid onward movement than for its intelligent retrospect of the past. It is reconstructive as well as progressive. The light which is kindled by the practical discoveries of modern science, throws back its rays, and enables us to distinguish objects of interest, which have been unnoticed in the gloom of bygone ages, or passed over with contempt.

Men observe only those things which their occupations or their education enable them to understand and appreciate. When a savage is introduced on board the deck of a European vessel, he notices only those objects with the uses of which he is familiar—the sewing of a

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coat, a chain or a cable at once rivets his attention, but he passes by the steam-engine without observation, and if a work of art is forced upon his notice, he is unable to say whether it represents a man, a ship, or a kangaroo!* So in past ages the flint implements of the drift, the parents of all our modern implements, whether for war or handicraft, must have been carted away in hundreds, unobserved, and in ignorance that these inconspicuous objects would one day be the means of upsetting the received chronology of our species.

Whilst, therefore, we devote our energies chiefly to progress, and fix our attention upon the present and future of war, it cannot fail to interest those who are actively engaged in the duties of their profession, if we occasionally take a glance backward and see what recent discoveries have done towards elucidating its origin and early history.

It might, perhaps, assist a right understanding of the principles on which the weapons and implements of savages deserve to be studied, if I were to notice some of those great questions respecting the origin of our species, and man's place in nature, which the investigations of science have been the means of raising in our day. I need hardly say that the rude implements, which I am about to describe, are of little practical interest in themselves, as models for instruction or imitation. We have no need of bows and arrows in the existing state of war, and if we did require them, the appliances of modern times would enable us to construct them in far greater perfection than could be acquired by any lessons from savages. These weapons are valuable only, in the absence of other evidence, from the light they throw on pre-historic times, and on those great questions to which I have alluded, and from their enabling us to trace out the origin of many of those customs which have been handed down to us by past generations.

As, however, the discussion of these interesting subjects would lead me into matters that are hardly suited to the Lecture-room of this Institution, I must pass over the consideration of them with a few brief remarks.

In so doing, I may appear to postulate some opinions upon points that are still the subject of animated controversy in the scientific world. But it would require a far broader field of investigation than is here afforded me, in order to treat these inquiries successfully, and to adduce all the evidence that would be necessary to support the hypotheses put forward; and I am anxious to devote no greater space to these preliminary remarks than is necessary to point out some of the main features of interest that are involved in the particular study which forms the subject of my lecture.

We are apt to speak of the creation of the universe as a thing of the past, and to suppose that the world, with all the varied life upon it, previous to man's appearance, having been created for his especial happiness and supremacy, was afterwards left to his control and government. But this view of the subject belongs to an age in which the laws of nature in their all-sufficiency and completeness were but little

* Beechey's Voyage to the Pacific, p. 298. Oldfield's Aborigines of Australia. Transactions of the Ethnological Society, vol. iii, new series, p. 227.

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studied and appreciated. Modern science finds no evidence of any such abandonment of the universe to man's jurisdiction. The more comprehensively the subject is viewed, the more restricted appear to be those limits over which the free will of mankind is permitted to range, and the more evident it becomes, that in his social advancement, his laws, arts, and wars, he moves on under the influence and development of those same laws which have been in force from the very first dawn of creation. The lower the archæologist searches in the crust of the earth for the relics of human art, the more faint become the traces of that broad gulf, which in our times appears to separate man from the brute creation. In all the numerous and varied offsprings of the human intellect, in the arts, and even in speech, the more we investigate and trace them back, the more clearly they appear to point to a condition of the human race in which they had no existence whatever. The great law of nature, "natura non facit saltum," was not broken by the introduction of man upon the earth. He appears to have been produced in the fulness of time, as the work of creation required a more perfect tool, and to have ameliorated his condition, only as the work to be performed became more complicated and varied, just as in the hands of man, the rougher tool is employed for felling, and the finer tool for finishing and polishing.

By this view we come to look upon even the most barbarous state of man's existence, as a condition, not so much of degradation, as of arrested or retarded progress, and to see that, notwithstanding many halts and relapses, and a very varied rate of movement in the different races, the march of the human intellect has been always onward.

As in the lower creation, we find no individuals that are capable of self-improvement, though some appear, by their imitative faculties, to contain within them the germs of an improving element, so the aboriginal man, closely resembling the brutes, may have passed through many generations before he began to show even the first symptoms of mental cultivation, or the rudiments of the simplest arts; and even then his progress may have been, at first, so slow, that it is not without an effort of imagination that the civilized races of our day can realise, by means of the implements which he has left us, the minute gradations which appear to mark the stages of his advancement. This appears to be the view taken by Sir Charles Lyell in his "Antiquity of Man," when, in comparing the flint implements found in the higher and lower level gravels of the valley of the Somme, he arrives at the conclusion, "that the state of the arts in those early times remained stationary for an almost indefinite period." "We see," he says, "in "our time, that the rate of progress in the arts and sciences proceeds "in a geometrical ratio as knowledge increases, and so, when we carry "back our retrospect into the past, we must be prepared to find the "signs of retardation augmenting in a like geometrical ratio. So that "the progress of a thousand years, at a remote period, may correspond "to that of a century in modern times, and in ages still more remote, "man would more and more resemble the brutes in that attribute "which causes one generation exactly to imitate, in all things, the "generation which preceded it."

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In order to understand the relationship which the savage tribes of our own time bear to the races of antiquity, it is necessary to keep in view that, neither in historic nor pre-historic times is there any evidence that civilization has been equally or universally distributed; on the contrary, it appears always to have been partial, and confined to particular races, whose function it has been by means of war and conquest, to spread the arts amongst surrounding nations, or to exterminate those whose low state of mental culture rendered them incapable of receiving it.

Assuming the whole of the human species to have sprung originally from one stock, an hypothesis which, although disputed, appears to me by all existing evidence and analogy of known facts, to be the most reasonable assumption, the several races appear to have branched off at various and remote periods, many of them, perhaps, previously to the present geographical arrangement of land and water, and to have located themselves in the several regions in which they are now found, in a state which probably differs but little from that in which they existed at the time of their separation from the parent stem.

Each race, after separation, shows evidence of arrested growth; and, finally, the intellect of the nation fossilizes and becomes stationary for an indefinite period, or until destroyed by being brought again in contact with the leading races in an advanced stage of civilization, precisely in the same way that the individuals composing these races, after propagating their species, stagnate, and ultimately decay, or, in a low state of savagery, are often destroyed by their own offspring.

Taking a comprehensive view of the development of civilization, it may be compared to the growth of those plants whose vigour displays itself chiefly in the propagation of their leading shoots, which, overtopping the older and feebler branches, cause them to be everywhere replaced by a fresh growth of verdure. The vegetable kingdom thus furnishes us with the grand type of progress; continuity and bifurcation are principles of universal application, uniting the lowest with the highest created thing.

The analogy of tree growth has been frequently employed in relation to natural phenomena, and it may very well be taken to explain the distribution of the human race, and the progress and expansion of the arts. It forms the key to the Darwinian theory of natural selection, which is essentially monogenistic in its application to the origin of the human race.

Thus the existing races of mankind may be taken to represent the budding twigs and foliage, each in accordance with the relative superiority of its civilization, appertaining to branches higher and higher, placed upon the great stem of life.

So little is as yet known of the early history of any but our own family of nations, that in the existing state of knowledge, the attempt to classify and place them on their proper branches, must be attended with much difficulty, and great liability to error. However, by arranging the existing races according to their civilization, a tolerably correct judgment may perhaps be formed as to the value of this system of classification, if we distribute them with those of antiquity in some

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two or three broad divisions. The Caucasian races of modern Europe, for example, may be said to bear to their ancestors of the historical period the same relationship that geologists have shown the existing mammalia of our forests bear to the mammalia of the tertiary geological period. The semi-civilized Chinese and Hindoos, in like manner, may be classed with the races of ancient Assyria, Egypt, and other nations immediately prior to the first dawn of history, the civilization of which nations they still so greatly resemble, and appear to have retained, in a state of retarded progress from those ages to our own. A third division may perhaps be made of the Malay, Tartar, and African negro nations, which though now in an age of iron, may, by the state of their arts, and more especially by the form of their implements, be taken as the best representatives of the pre-historic bronze period of Europe, towards which they appear to hold the same relationship that the fish and reptiles of our seas bear to those of the secondary geological period. In a fourth division may be included the still more barbarous races of our times, the Australian, Bushman, and hunting races of America, whose analogy to those of the stone age of Europe may be typified by that of the mollusca of recent species to the mollusca of the primary geological period.

In all these existing races, we find that the slowness of their progression and incapacity for improvement is proportioned to the low state of their civilization, thereby leading to the supposition that they may have retained their arts with but slight modification from the time of their branching from the parent stem, and may thus be taken as the living representatives of our common ancestors in the various successive stages of their advancement.

Many examples of this immobility on the part of savages and semi-civilized races may be given.

Throughout the entire continent of Australia the weapons and implements are alike, and of the simplest form, and the people are of the lowest grade. The spear, the waddy, and the boomerang, with some stone hatchets, are their only weapons; but amongst these it has been noticed that, like the implements of the drift, there are minute differences, scarcely apparent to Europeans, but which enable a native to determine at a glance to what tribe a weapon belongs.* This, whilst it proves a tendency to vary their forms, shows at the same time either an incapacity or, what answers the same purpose, a retarding power or prejudice, which prevents their effecting more than the smallest appreciable degree of change. In the island of Tahiti, Captain Cook was unable to make the natives (a superior race to the Australians) appreciate the uses of metal, until he had caused his armourer to construct an iron adze (Plate XLVIII, fig. 1 *a*) of precisely the same form as their own adzes of basalt (Fig. 1 *b*).† After that, metal tools came into general use amongst them, though their old forms are in a great measure preserved to this day. When during the American

* A. Oldfield on the Aborigines of Australia. Trans. Ethno. Soc., vol. iii, p. 261, 267.

† See the figures in Meyrick's Ancient Arms, &c., pl. cxlix.

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war, the English endeavoured to utilise the Indians by arming them, they were compelled to construct for them tomahawks after their own pattern, having a pipe in the handle (Fig. 2). When the Purus Indians of South America receive a knife from Europeans they break off the handle, and fashion the knife according to their own ideas, placing the blade between two pieces of wood, and binding it round tight with a sinew.* The natives of Samoa now use iron adzes, constructed after the exact pattern of their ancient stone ones.† The Fije Islanders, though they have now the means of obtaining good blades and chisels from Sheffield, and axes from America, prefer plane irons to any other form of implement, because they are able to fix them by lashing them on to their handles in the same fashion as the ancient stone adzes of their own manufacture, which they resemble.‡ The Andaman Islanders use the European metal that falls into their hands, only to grind it down into spear- and arrow-heads of the same form as their stone ones. The same applies to the whole of the Aborigines of North and South America, which have stood by, for nearly three centuries, passive spectators of the arts of Europeans, without attempting to copy them. Mr. Crawfurd, in his history of the Indian Archipelago, comments on the obstinate adherence of the Javanese to ancient customs, in accounting for the kris having been retained by them long after the causes which produced that peculiar weapon had ceased to operate. Tylor, in his account of the Anahuac, observes upon the preservation of old types amongst the present inhabitants of Mexico, which have remained almost unchanged from generation to generation, enabling the historian to distinguish clearly those which are of Aztec from those which are of Spanish origin.§ Herodotus describes the spears carried by the Ethiopians in the army of Xerxes as being armed with the sharpened horn of the antelope.‖ Consul Petherick found still in use by the Djibba negroes more than two thousand years after, these identical spears, armed with the straightened and sharpened horn of the antelope, and their other weapons also resembled in character those described by Herodotus, although they had passed from the stone weapons then used, into an age of metal.¶ The Scythian bow (Fig. 3) is the bow still used by the whole of the Tartar races (Fig. 4). The Celt of the Tartar, and the Celt and sword of the Negro (Fig. 5) is still the Celt and sword of the European bronze period (Fig. 6), and this resemblance is not confined to the general outline of the weapons, but extends to the style and patterns of ornamentation. The same identity of form exists between the Manillas (Fig. 7) used as a medium of exchange in the Eboe country of West Africa and the so-called penannular rings or ring money (Fig. 8) of gold and bronze that are found in Ireland, and which, with some modifications, belong also to Germany and the

* Klemm-Werkzeuge und Waffen, p. 159.
† Turner, Nineteen Years in Polynesia, p. 262.
‡ Fije and the Fijeans, p. 78.
§ Anahuac, by E. B. Tylor, p. 70.
‖ Rawlinson's Herodotus, vol. iv, p. 69.
¶ Petherick's Travels, p. 360.

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Swiss Lakes. The corrugated iron blade of the Kaffir assegai, a section of which is shown in Fig. 9, and which is used also in Central and West Africa, is identical with those found in the Saxon graves (Fig. 10), and is intended to give a spiral motion to these missiles. Chevalier Follard observes that the Gauls were remarkable for the tenacity with which they clung to their ancient customs, while the Romans, their conquerors, are mentioned by all historians as peculiar in their time for the facility with which they adopted the customs of others, and developed their own. In modern Europe, the Gypsies have also been noticed as being distinguished from the Europeans in all the various localities in which they are found, for their remarkable adherence to especial arts, savouring of an extinct civilization. Amongst the Chinese and Hindoos, the conservatism which has caused them to remain for ages in nearly the same condition is too well known to require comment. It will, however, be remembered, in illustration of the fact, that customs of minor importance often survive great political changes, and serve to keep up the continuity that would otherwise be broken; that after the Manchu Tartars had conquered and established themselves in the Chinese territory, they were nearly driven again from the country, on account of their forcing upon the subject people, the custom of wearing pigtails, after the fashion of their conquerors, showing how difficult it is to ingraft upon an alien race, customs that are not indigenous.

These, and many other notices of a similar character that are to be found in the pages of travel, establish it as a maxim, that the existing races, in their respective stages of progression, may be taken as the *bonâ fide* representatives of the races of antiquity; and, marvellous as it may appear to us in these days of rapid progress, their habits and arts, even to the form of their rudest weapons, have continued in many cases, with but slight modifications, unchanged throughout countless ages, and from periods long prior to the commencement of history. They thus afford us living illustrations of the social customs, the forms of government, laws, and warlike practices, which belonged to the ancient races from which they remotely sprung, whose implements, resembling, with but little difference, their own, are now found low down in the soil, in situations, and under circumstances in which, alone, they would convey but little evidence to the antiquary, but which, when the investigations of the antiquary are interpreted by those of the ethnologist, are teeming with interesting revelations respecting the past history of our race, and which, in the hands of the anthropologist, in whose science that of antiquity and ethnology are combined with physiology and geology, is no doubt destined to throw a flood of light, if not eventually, in a great measure, to clear up the mystery which now hangs over everything connected with the origin of mankind.

That such a combination of the sciences should have been brought about so opportunely in our days, appears to me to be one of those many indications of an overruling power directing in the aggregate the minds of men, and which must, at all times, strike even the most superficial observer of nature; for there can be little doubt that in a few

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years all the most barbarous races will have disappeared from the earth, or will have ceased to preserve their native arts.

The law which consigns to destruction all savage races when brought in contact with a civilization much higher than their own, is now operating with unrelenting fury in every part of the world. Of the aborigines of Tasmania, not a single individual remains; those of New Zealand are fast disappearing. The Australian savage dies out before the advancing European. North and South America, and the Polynesian Islands, all tell the same tale. Wherever the generous influences of Christianity have set foot, there they have been accompanied by the scourge. Innumerable, and often unseen causes, combine in effecting the same purpose; diseases which are but little felt by Europeans, act as plagues when introduced into uncivilized communities, and cause them to fall before its ravages, like wheat before the sickle; and the vices of civilization, taking a firmer hold of the savages than its virtues, aid and abet in the same work. The labours of the missionary, if they have produced no other benefit, have been useful in teaching us the great truth, that notwithstanding the philanthropic efforts of the intruding race, the law of nature must be vindicated. The savage is morally and mentally an unfit instrument for the spread of civilization, except when, like the higher mammalia, he is reduced to a state of slavery; his occupation is gone, and his place is required for an improved race. Allowing for the rapidly increasing ratio in which progress advances, it is not too much to assume, that in half a century from the present time, savage life will have ceased to have a single true representative on the face of the globe, and the evidence which it has been the means of handing down to our generation will have perished with it.

When we find that the condition of the aboriginal man must have been one of such complete inanity as to render him incapable of spontaneously initiating even the most rudimentary arts, it follows as a matter of course that in the earliest stages of his career, he must, like children of our own day, have been subject to compulsory instruction. And in looking to nature for the sources from which such early instruction must have been derived, we need not, I think, be long in coming to the conclusion, that the school of our first parents must be sought for in his struggles for mastery with the brute creation, and that, consequently, his first lessons must have been directed to attaining proficiency in the art of war.

Hence it follows that it is to the lower animals that we must look for the origin of all those branches of primitive warfare which it is the object of this lecture to trace out. Nor indeed shall we fail to find abundant evidence that there is hardly a single branch of human industry which may not reasonably be attributed to the same source.

The province of war extends downward through the animal kingdom, shewing unmistakeable evidence of its existence in forms offensive and defensive, differing but little from those of the human era, through the unnumbered ages of the geological periods, long prior to man's advent, proving, beyond the possibility of doubt, that from the

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remotest age in which we find evidence of organised beings, war has been ordained to an important function in the creative process.

Judging by results, which I apprehend is the only true method of investigating the phenomena of life, three primary instincts appear to have been implanted in nearly all the higher animals:* alimentiveness, for the sustenance of life; amativeness, for the propagation of species; and combativeness, for the protection of species, and the propagation by natural selection of the most energetic breeds; on which latter subject much important information has been given to the world by Mr. Darwin, in his celebrated work on the origin of species.

Much might, I believe, be said on the connection which subsists between these functions, all of which are, in some form or other, necessary to a healthy condition. Suffice, however, to observe, that as regards the dawn of an Utopia, in which some men who think themselves practical, appear to indulge; whether we study the subject by observing the uses to which animals apply the various and ingeniously constructed weapons with which Providence has armed them, or whether we view it in relation to the prodigious armaments of all the most civilised nations of Europe, we find no more evidence in nature, of a state of society in which wars shall cease, than we do of a state of existence in which we shall support life without food, or propagate our species by other means than those which nature has appointed.

The universality of the warlike element is shewn in the fact, that the classification of the weapons of men and animals are identical, and may be treated under the same heads.

Many constructive arts are brought to greater perfection in animals by the development of faculties, especially adapting them to the peculiar implements with which nature has furnished them, than can be attained by man, and especially by the aboriginal man, whose particular attribute appears, by all analogy of savage life, to have been an increase of that imitative faculty which, in the lower creation, is found only in a modified degree in apes.

The lower creation would thus furnish man not only with the first elements of instruction, but with examples for the improvement of the work commenced, or to use the words of Pope:—

> "From the creatures thy instruction take,
> "Thy arts of building from the bee receive;
> "Learn from the mole to plough, the worm to weave;
> "Learn from the little nautilus to sail,
> "Spread the thin oars, and catch the driving gale;
> "Here, too, all forms of social reason find,
> "And hence let reason late instruct mankind."†

In the art of war, as we shall see, he would not only derive his first instruction from the beasts, but he would improve his means of offence

* In adopting the nomenclature of phrenology, I am not to be understood as advocating strictly the localization of the faculties which phrenology prescribes. The mind doubtless consists of a congeries of faculties, and phrenology affords the best classification of them that has yet been devised.

† Pope's Essay on Man, epistle iii.

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and defence from time to time by lessons derived from the same source.

It therefore appears desirable that, before entering upon that branch of the subject which relates to the *progress* and *development* of the art of war, I should point out briefly the analogies which exist between the weapons, tactics, and stratagems of savages and those of the lower creation, and shew to what extent man appears to have availed himself of the weapons of animals for his own defence.

In so doing the subject may be classified as follows :—

Classification of the Weapons of Animals and Savages.

Defensive.	Offensive.	Stratagems.
Hides.	Piercing.	Flight.
Solid plates.	Striking.	Concealment.
Jointed plates.	Serrated.	Tactics.
Scales.	Poisoned.	Columns.
	Missiles.	Leaders.
		Outposts.
		Artificial defences.
		War cries.

Firstly, with respect to the combative principle itself. The identity of this instinct in men and animals may be seen in the widely-spread custom of bating animals against each other, a practice which is not derived from any one source, but is indigenous in the countries in which it prevails, and arises from the inherent sympathy which exists between men and animals in the exercise of this particular function.

In the island of Tahiti, long before the first European vessel was seen off their shores, the inhabitants were accustomed to train and fight cocks, which were fed with great care, and kept upon finely-carved perches.* Cock-fighting also prevails amongst the Malays, Celebes, and Balinese. The Javanese fight their cocks like the Mahommedans of Hindustan, without spurs; the Malays, Bugis, and Macassars with artificial spurs shaped like a scythe.† It also prevails in Central Africa, Central America, and Peru. The Sumatrans fight their cocks for vast sums; a man has been known to stake his wife and children, son, mother, or sister on the issue of a battle, and when a dispute occurs, the owners decide the question by an appeal to the sword. In like manner Adrastus, the son of Midas, King of Phrygia, is said to have killed his brother in consequence of a quarrel which took place between them in regard to a battle of quails.

When Themistocles led the Greeks out against the Persians, happening to see two cocks fight, he shewed them as an example to his soldiers. Cock-fighting was afterwards exhibited annually in presence

* Ellis's Polynesian Researches, vol. i, p. 222.
† Crawfurd's Indian Archipelago, vol. i, p. 116.

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of the whole people, and the crowing of a cock was ever after regarded as a presage of victory.*

The Javanese also fight hogs and rams together. The buffalo and tiger are matched against each other. In Butan the combat is between two bulls. Combats of elephants took place for the amusement of the early Indian kings. The Chinese and Javanese fight quails, crickets, and fish. The Romans fought cocks, quails, and partridges, also the rhinoceros. In Stamboul two rams are employed for fighting. The Russians fight geese, and the betting runs very high upon them.† We find horses, elephants, and oxen standing side by side with man in hostile array, and dogs were used by the Gauls for the same purpose. Amongst the ancients, the horse, the wolf, and the cock were offered on the altar of Mars for their warlike qualities.

Who can doubt with these examples before us, that an instinct so widely disseminated and so identical in men and animals, must have been ordained for special objects?

The causes which give rise to the exercise of the function, vary with the advance of civilization. We have now ceased to take delight in the mere exhibition of brute combats, but the profession of war is still held in as much esteem as at any previous period in the history of mankind, and we bestow the highest honours of the State upon successful combatants.

This however leads to another subject, viz., the causes of war amongst primitive races which is deserving of separate treatment.

Defensive Weapons.

We may pass briefly over the defensive weapons of animals and savages, not by any means from the analogy being less perfect in this class of weapons, but rather because the similarity is too obvious to make it necessary that much stress should be laid on their resemblance.

Hides.—The thick hides of pachydermatous animals, correspond to the quilted armour of ancient and semi-civilized races. Some animals like the rhinoceros and hippopotamus are entirely armed in this way, others have their defences on the most vulnerable part, as the mane of the lion, and the shoulder pad of the boar.‡ The skin of the tiger is of so tough and yielding a nature, as to resist the horn of the buffalo when driven with full force against its sides.§ The condor of Peru has such a thick coating of feathers, that eight or ten bullets may strike without piercing it.‖

According to Thucydides, the Locrians and Acarnanians, being professed thieves and robbers, were the first to clothe themselves in armour. But as a general rule it may be said, that the opinions of

* Beckman's History of Inventions—Cock-fighting.
† Stanley's History of Birds, p. 361.
‡ Darwin, Origin of Species, p. 88.
§ Williamson's Field Sports.
‖ Swainson's Habits and Instincts of Animals.

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ancient writers upon the origin of the customs with which they were familiar, are of little value in our days. There is however evidence to show, that the use of defensive armour is not usual amongst savages in the lowest stages of culture. It is not employed, properly speaking, by the Australians, the Bushmen, the Fuegians, in the Fije or Sandwich Islands. But in many other parts of the world, soon after men began to clothe themselves in the skins of beasts, they appear to have used the thicker hides of animals for purposes of defence. When the Esquimaux apprehends hostility, he takes off his ordinary shirt, and puts on a deer's skin, tanned in such a manner as to render it thick for defence, and over this he again draws his ordinary shirt, which is also of deer-skin, but thinner in substance. The Esquimaux also use armour of eider drake's skin.* The Abipones and Indians of the Gran Chako, arm themselves with a cuirass, greaves, and helmet, composed of the thick hide of the tapir, but they no longer use it against the musketry of the Europeans. The Yucanas also use shields of the same material. The war dress of a Patagonian chief from the Museum of the Institution is exhibited (Plate XLIX, figs. 11, 12); it is composed of seven thicknesses of hide, probably of the horse, upon the body, and three on the sleeves. The chiefs of the Musgu negroes of Central Africa, use for defence a strong doublet of the same kind, made of buffalo's hide with the hair inside.† The Kyans of Borneo use hide for their war dress as shown by a specimen belonging to the Institution (Fig. 13). The skin of the bear and panther is most esteemed for this purpose.‡ The inhabitants of Pulo Nias, an island off the western coast of Sumatra, use for armour a baju made of leather.§ In some parts of Egypt a breast plate was made of the back of the crocodile (Fig. 14). In the island of Cayenne, in 1519, the inhabitants used a breast plate of buffalo's hide.‖ The Lesghi of Tartary wore armour of hog's skin.¶ The Indians of Chili, in the 17th century, wore corselets, back and breast-plates, gauntlets, and helmets of leather, so hardened, that it is decribed by Ovalle as being equal to metal.** According to Strabo, the German Rhoxolani wore collars, helmets, and shields of bull's hide, though the Germans generally, placed little reliance in defensive armour. The Ethiopians used the skins of cranes and ostriches for their armour.††

We learn from Herodotus that it was from the Lybians, the Greeks derived the apparel and ægis of Minerva, as represented upon her images, but instead of a pectoral of scale armour, that of the Lybians was merely of skin.‡‡ According to Smith's dictionary of Greek and

* Beechey's Voyage to the Pacific, vol. i, p. 248.
† Barth, vol. iii.
‡ Sarawak, by Hugh Low, Esq., Colonial Secretary at Labuan, 1848.
§ Dobrizhoffer.
‖ Pigafetta's Voyage Round the World. Pinkerton, vol. ix, p. 349.
¶ Travels of William de Rubruquis into Tartary and China in 1253; Pinkerton, vol. viii, p. 89.
** An Historical relation of the Kingdom of Chile, by Alonso de Ovalle, of the Company of Jesus, 1649.
†† Herodotus; Meyrick's Ancient Armour.
‡‡ Meyrick's Ancient Armour, vol. i, pl. iv.

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Roman Antiquities, the Greek thorax, called στάδιος, from its standing erect by its own stiffness, was originally of leather, before it was constructed of metal. In Meyrick's Ancient Armour, there is the figure of a suit, supposed formerly to have belonged to the Rajah of Guzerat (Plate L, fig. 15). The body part of this suit is composed of four pieces of rhinoceros hide, showing that, in all probability, this was the material originally employed for that particular class of armour, which is now produced of the same form in metal, a specimen of which, from the Museum of the Institution, taken from the Sikhs, is now exhibited (Fig. 16).

In more advanced communities, as skins began to be replaced by woven materials, quilted armour supplied the place of hides. In those parts of the Polynesian Islands, in which armour is used, owing probably to the absence of suitable skins, woven armour appears to have been employed in a comparatively low state of society. Specimens of this class of armour from the Museum of the Institution are exhibited; they are from the King's Mill, Pleasant Island, and the Sandwich Islands. A helmet from the latter place (Fig. 17) much resembles the Grecian in form, while the under tippet, from Pleasant Island (Plate XLIX, fig. 18), may be compared to the pectoral of the Egyptians (Fig. 19, *a* and *b*), which, as well as the head dress (Plate L, fig. 20), was of a thickly quilted material. The Egyptians wore this pectoral up to the time of Xerxes, who employed their sailors, armed in this way, during his expedition into Greece. Herodotus says that the Indians of Asia wore a thorax of rush matting. In 1514, Magellan* found tunics of quilted cotton, called laudes, in use by the Muslims of Guzerat and the Deccan. An Indian helmet of this description from my collection (Fig. 21) is exhibited; in form it resembles the Egyptian, and an Ethiopian one (Fig. 22), composed of beads of the same form, brought from Central Africa by Consul Petherick is exhibited. Fig. 23 shows that the same form, in India, was subsequently produced in metal. A suit of quilted armour formerly belonging to Koer Singh, and lately presented to the Institution by Sir Vincent Eyre is also exhibited (Plate XLIX, fig. 24). The body armour and helmet found upon Tippoo Saib at his death, and which is now in the Museum of the Institution (Plate LI, fig. 25, *a*, *b*, and *c*), was thickly quilted. Upon the breast, this armour consists of two sheets of parchment, and nine thicknesses of padding composed of cocoons of the Saturnia mylitta, stuffed with the wool of the Eriodendron anfractuosum, D. C., neatly sewn together, as represented in Fig. 25 *b*.† The Aztecs and Peruvians also guarded themselves with

* The Coasts of East Africa and Malabar, by Duarte Barbosa, translated from the Spanish, by the Hon. H. E. Stanley, for the Hakluyt Society. Since publication, the translator has ascertained that the authorship of this work should be ascribed to Magellan.

† The Saturnia mylitta is the caterpillar from which the Tusseh-silk is obtained, the cocoon is of an oval shape when suspended upon the tree, and of exceedingly firm texture; it is figured in Sir Wm. Jardine's Naturalist's Library, vol. xxxii. The Eriodendron anfractuosum, D. C., is an Indian Bombax. The woolly cotton which envelopes the seed is remarkable for its softness, and is much and deservedly esteemed for making cushions and bedding, owing to its freedom from any tendency to become lumpy and uneven by getting impacted into hard knots. Various

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a wadded cotton doublet.* Quilted armour or thick linen corselets were used by the Persians, Phœnicians, Chalibes, Assyrians, Lusitanians, and Scythians, by the Greeks, and occasionally by the Romans. By the Persians it was used much later; and in Africa to this day, quilted armour, of precisely the same description, is used both for men and horses by the Bornouese of Central Africa, and is described by Denham and Clapperton (Plate L, fig. 26). Plate XLIX, fig. 27 is a suit of armour in the Institution, from the Navigator's Islands, composed of cocoa-nut fibre coarsely netted. Fig. 28 is part of a Chinese jacket of sky-blue cotton, quilted with enclosed plates of iron, it is precisely similar to the Brigandine jacket used in Europe in the 16th century, which was composed of "small plates of iron quilted within some stuff, and "covered generally with sky-blue cloth."† This class of armour may be regarded as a link connecting the quilted, with the scale armour, to be described hereafter.

As a material for shields, the hides of animals were employed even more universally, and up to a later stage of civilization. In North America, the majority of the wild tribes use shields of the thickest parts of the hides of the buffalo.‡ In the New Hebrides, the skin of the alligator is used for this purpose, as appears by a specimen belonging to the Institution. In Africa, the Fans of the Gaboon employ the hide of the elephant for their large rectangular shields.§ The Wadi, the Wagogo, and the Abyssinians in East Africa, have shields of buffalo's hide, or some kind of leather, like the Ethiopians of the time of Herodotus. The ox-hide shields of the Greeks are mentioned in Homer's Iliad; that of Ajax was composed of seven hides with a coating of brass on the outside. The spear of Hector is described as piercing six of the hides and the brass coating, remaining fixed in the seventh hide.|| The Caffres, Bechuanas, Bassutos, and others in South Africa, use the hide of the ox.¶ The Kelgeres, Kelowi, and Tawarek, of Central Africa, employ the hide of the Leucoryx antelope.** Shields of the rhinoceros hide, from Nubia, and of the ox, from Fernando Po, are exhibited. In Asia, the Biluchi carry shields of the rhinoceros horn, and the same material is also used in East Africa.†† A specimen from Zanzibar is in the Institution. In the greater part of India, the shields are made of rhinoceros and buffalo's

attempts have been made to fabricate it into cloth, but hitherto without success, except as a very loose material, fit only for quilting muffs, for which it is superior to cotton or woollen stuffs, the looseness of its texture rendering it an excellent non-conductor, whilst at the same time it is extremely light.—Illustrations of Indian Botany, by Robert Wight, M.D., F.L.S., vol. 1, p. 68.—Flora Indica.—Roxburgh, vol. iii, p. 169. Both the caterpillar and the plant are found in the jungle in the neighbourhood of Seringapatam. For the identification of the vegetable substance, I am indebted to W. Carruthers, Esq., F.L.S., British Museum.

* Schoolcraft.—Meyrick.

† See Critical Enquiry into Ancient Armour, by Sir Samuel R. Meyrick, vol. iii, p. 21, and pl. lxviii.

‡ Bollaert, Indians of Texas, Trans. Ethno. Soc., vol. 1-2.

§ Du Chaillu, p. 79, 80.

|| Iliad, vii.

¶ Cassalis.

** Barth, vol. i.

†† Meyrick, pl. cxlvii.

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hide, boiled in oil, until they sometimes become transparent, and are proof against the edge of a sabre.*

In a higher state of civilization, as the facilities for constructing shields of improved materials increased, the skins of animals were still used to cover the outside. Thus the negroes of the Gold Coast made their shields of osier covered with leather.† That of the Kanembu of Central Africa is of wood covered with leather,‡ and very much resembles in form that of the Egyptians, which, as we learn from Meyrick and others, was also covered with leather, having the hair on the outside like the shields of the Greeks.§ The Roman scutum was of wood covered with linen and sheepskin. According to the author of "Horæ Ferales," the Saxon shield was of wood covered with leather; the same applies to the Scotch target, and leather was used as a covering for shields, as late as the time of Henry VIII.

Head Crests.—The origin of the hairy crests of our helmets, is clearly traceable to the custom of wearing for head-dresses the heads and hair of animals. The Asiatic Ethiopians used as a head-covering, the skin of a horse's head, stripped from the carcase together with the ears and mane, and so contrived, that the mane served for a crest, while the ears appeared erect upon the head. In the coins representing Hercules, he appears wearing a lion's skin upon the head. These skins were worn in such a manner that the teeth appeared grinning at the enemy over the head of the wearer, as represented in Plate L, fig. 29, which is taken from a bronze in the Blacas collection, a custom which seems also to have prevailed in Mexico.‖ Similar head-dresses are worn by the soldiers on Trajan's column. The horns worn on the heads of some of the North American Indians (Fig. 30), and in some parts of Africa,¶ are no doubt derived from this practice of wearing on the head, the skins of animals with their appendages. The helmet of Pyrrhus, King of Epirus, was surmounted by two goat's horns. Horns were afterwards represented in brass, on the helmets of the Thracians (Fig. 31), the Belgic Gauls, and others. Fig. 32 is an ancient British helmet of bronze lately found in the Thames, surmounted by straight horns of the same material.** Horned helmets are figured on the ancient vases. Fig. 33 is a Greek helmet having horns of brass, and traces of the same custom may still be observed in heraldry.††

The practice of wearing head-dresses of feathers, to distinguish the chiefs from the rank and file, is universal in all parts of the world, and in nearly every stage of civilization. Amongst the North American Indians, the feathers are cut in a particular manner to denote the rank of the wearer, precisely in the same manner that the long feathers of

* Meyrick's Engraved Illustrations of Ancient Armour, by J. Skelton, F.S.A., vol. ii, pl. cxli.

† Bosman's Guinea, Pinkerton, vol. xii, p. 413.

‡ Barth, Denham and Clapperton.

§ Meyrick, vol. i, p. 111. ‖ Meyrick, vol. i, p. 20.

¶ At Fernando Po.—Cumming on Weapons and Armour of Horn, Journal of the Archæological Association, vol. iii.

** Fig. 32 is from a rough sketch taken about two years ago, and has no pretension to accuracy of detail.

†† Meyrick, vol. i, pl. iv.

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our general officers distinguish them from those wearing shorter feathers in subordinate ranks. This custom, Mr. Schoolcraft observes, when describing the head-dresses of the American Indians, may very probably be derived from the feathered creation, in which the males, in most of the cock, turkey, and pheasant tribes, are crowned with bright crests and ornaments of feathers.

Solid Plates.—It has often struck me as remarkable that the shells of the tortoise and turtle, which are so widely distributed and so easily captured, and which would appear to furnish shields ready made to the hand of man, should seldom, if ever, in so far as I have been able to learn, be used by savages for that purpose. This may, however, be accounted for by the fact that *broad* shields of that particular form, though common in more advanced civilizations, are never found in the hands of savages, at least in those localities in which the turtle, or large tortoise, is available.

It will be seen subsequently, in tracing the history of the shield, that in the rudest condition of savage life, this weapon of defence has a history of its own; that both in Africa and Australia, it is derived by successive stages from the stick or club, and the broad shield does not appear to have been developed until after mankind had acquired sufficient constructive skill to have been able to form shields of lighter and more suitable materials than is afforded by the shell of the turtle. It is, however, evident that in later times, the analogy was not lost sight of, as the word testudo is a name given by the Romans to several engines of war having shields attached to them, and especially to that particular formation of the legionary troops, in which they approached a fortified building with their shields joined together, and overlapping, like the scaly shell of the imbricated turtle, which is a native of the Mediterranean and Asiatic seas.

Jointed Plates.—In speaking of the jointed plates, so common to all the crustacea, it is sufficient to notice that this class of defence in the animal kingdom, may be regarded as the prototype of that peculiar form of armour which was used by the Romans, and to which the French, at the commencement of the 17th century, gave the name of "écrevisses," from its resemblance to the shell of a lobster. The fluted armour, common in Persia, and, in the middle ages, of Europe, is also constructed in exact imitation of the corrugated shell defences of a large class of the Mollusca.

Scale armour.—That scale armour derived its origin from the scales of animals, there can be little doubt. It has been stated on the authority of Arrian, that the Greeks distinguished scale armour by the term λεπιδωτός, expressive of its resemblance to the scales of fish whilst the jointed armour, composed of long flexible bands, like the armour of the Roman soldier, and the écrevisses of the middle ages was called φολιδωτός from its resemblance to the scales of serpents. The brute origin of scale armour is well illustrated by the breast plate of the Bugo Dyaks, a specimen of which, from the Museum of the Institution, is exhibited (Plate LI, fig. 34). The process of its construction was described in a notice attached to a specimen of this armour in the Exhibition of 1862. The scales of the Pangolin are collected by the Bugis

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as they are thrown off by the animal, and are stitched on to bark with small threads of cane, so as to overlap each other in the same manner that they are arranged on the skin of the animal. When the front piece is completely covered with scales, a hole is cut in the bark for the head of the wearer. The specimen now exhibited appears, however, to be composed of the entire skin of the animal. Captain Grant, in his "Walk across Africa," mentions that the scales of the armadillo are in like manner collected by the negroes of East Africa, and worn in a belt "three inches across," as a charm.*

It is reasonable to suppose that the use of scale armour, in most countries, originated in this manner by sewing on to the quilted armour before described, fragments of any hard material calculated to give it additional strength. Plate L, fig. 35 is a piece of bark from Tahiti, studded with pieces of cocoa-nut stitched on. The Sarmatians and Quadi are described by Ammianus Marcellinus as being protected by a lorica, composed of pieces of horn, planed and polished, and fastened like feathers upon a linen shirt.† Pausanias also, who is confirmed by Tacitus, says that the Sarmatians had large herds of horses, that they collected the hoofs, and after preparing them for the purpose, sewed them together, with the nerves and sinews of the same animal, so as to overlap each other like the surface of a fir cone, and he adds, that the lorica thus formed was not inferior to that of the Greeks either in strength or elegance. The Emperor Domitian had, after this model, a cuirass of boar's hoofs stitched together.‡ Fig. 36 represents a fragment of scale armour made of horn found at Pompeii. A very similar piece of armour (Fig. 37), from some part of Asia, said to be from Japan, but the actual locality of which is not known, is figured in Meyrick's Ancient Armour, Pl. L. It is made of the hoofs of some animal, stitched and fastened so as to hold together without the aid of a linen corselet. An ancient stone figure§ (Plate LI, fig. 38), having an inscription in a character cognate to the Greek, but in an unknown language, and covered with armour of this description, is represented in the third volume of the Journal of the Archæological Association. The Kians inhabiting the eastern coast of Borneo, form a kind of armour composed of little shells placed one overlapping the other, like scales, and having a large mother-of-pearl shell at the end. This last portion of the armour is shown in the figure of the Kian war-dress already referred to (Fig. 13). Plate L, fig. 39 is a back- and breast-piece of armour from the Sandwich Islands, composed of seals' teeth, set like scales, and united with string.

Similar scales would afterwards be constructed in bronze and iron. It was thus employed by the Egyptians (Plate LI, fig. 40), two scales of which are shown in Fig. 41; also by the Persians, Assyrians, Philistines, Dacians, and most ancient nations.

The armour of Goliah is believed to have been of scales, from the fact of the word "kaskassim," used in the text of 1 Samuel, xvii.

* Walk across Africa, p. 47.
† Smith's Dictionary—Meyrick's Ancient Armour, pl. iii.
‡ Pictorial Bible, note to 1 Samuel, chap. xvii.
§ Cumming—Journal of the Archæological Association, vol. iii.

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being the same employed in Leviticus and Ezekiel, to express the scales of fish.* Amongst the Romans, scale armour was regarded as characteristic of barbarians, but they appear to have adopted it in the time of the Emperors. A suit of Japanese armour in my collection shows four distinct systems of defence, the back and breast being of solid plates, the sleeves and leggings composed of small pieces of iron, stitched on to cloth, and united with chain, whilst other portions are quilted with enclosed pieces of iron (Fig. 42, *a* and *b*). Fig. 43, *a* and *b*, is a suit of Chinese armour, in the Museum, having large iron scales on the inside (Fig. 44). This system was also employed in Europe. Fig. 45 is the inner side of a suit of Jazerine armour of the 15th or 16th century, in my collection. Fig. 46 represents a similar suit in the Museum of the Institution, probably of the same date, having large scales of iron on the outside. A last vestige of scale armour may be seen in the dress of the Albanians which, like the Scotch and ancient Irish kilt, and that formerly worn by the Maltese peasantry, is a relic of costume of the Greek and Roman age. In the Albanian jacket the scales are still represented in gold embroidery.†

Offensive Weapons of Men and Animals.

Piercing Weapons.—The Gnu of South Africa, when pressed, will attack men, bending its head downwards, so as to pierce with the point of its horn.‡ The same applies to many of the antelope tribe. The rhinoceros destroys the elephant with the thrust of its horn, ripping up the belly (Plate LII, fig. 47). The horn rests on a strong arch formed by the nasal bones; those of the African rhinoceros, two in number, are fixed to the nose by a strong apparatus of muscles and tendons, so that they are loose when the animal is in a quiescent state, but become firm and immovable when he is enraged, showing in an especial manner that this apparatus is destined for warlike purposes.§ It is capable of piercing the ribs of a horse, passing through saddle, padding, and all.‖ Mr. Atkinson, in his Siberian Travels, speaks of the tusk of the wild boar, which in those parts is long, and as sharp as a knife, and he describes the death of a horse which was killed by a single stroke from this animal, delivered in the chest.¶ The buffalo charges at full speed with its horns down.** The bittern, with its beak, aims always at the eye.†† The walrus (Fig. 48) attacks fiercely with its

* Pictorial Bible, note to 1 Samuel xvii.
† Skene on the Albanians, vol. i–ii—Ethnological Journal.
‡ Cassalis, Account of the Bassutos, p. 172.
§ Maunder's Treasury of Natural History.
‖ Williamson's Field Sports, vol. i, p. 174.
¶ Atkinson's Travels in Siberia, p. 425.
** Williamson's Field Sports.
†† Thompson's Passions of Animals, p. 225. The American hunter avails himself of this pecularity to entrap the crane by presenting the barrel of his firelock to the animal; supposing it to be an eye, the crane immediately strikes at the hole, and fixes its beak firmly in the muzzle.

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pointed tusks, and will attempt to pierce the side of a boat with them.* The needle fish of the Amazons is armed with a long pointed lance.† The same applies to the sword-fish of the Mediterranean and Atlantic (Fig. 49), which, notwithstanding its food is mostly vegetable, attacks the whale with its spear point on all occasions of meeting. There is an instance on record of a man, whilst bathing in the Severn near Worcester, having been killed by the sword-fish.

The weapon of the sword-fish is used as a spear-head by the wild tribes of Cambodia, and some idea may be formed of its efficiency for this purpose, and of the confidence with which it is used, by the following account of an attack on a rhinoceros with this weapon, by Mons. Mouhot.‡ He says :—

"The manner in which the rhinoceros is hunted by the Laotians is "curious, on account of its simplicity and the skill they display. They "had bamboos, with iron blades, something between a bayonet and a "poignard. The weapon of the chief was the horn of a sword-fish, "long, sharp, strong, supple, and not likely to break. Thus armed, "we set off into the thickest part of the forest, with all the windings "of which our leader was familiar, and could tell with tolerable cer-"tainty where we should find our expected prey. After penetrating "nearly two miles into the forest, we suddenly heard the crackling of "branches, and rustling of the dry leaves. The chief went on in "advance, signing to us to keep a little way behind, but to have our "arms in readiness. Soon our leader uttered a shrill cry, as a token "that the animal was near. He then commenced striking against "each other two bamboo canes, and the men set up wild yells to pro-"voke the animal to quit his retreat.

"A few minutes only elapsed before he rushed towards us, furious "at having been disturbed. He was a rhinoceros of the largest size, "and opened a most enormous mouth. Without any sign of fear, but "on the contrary of great exultation, as if sure of his prey, the "intrepid hunter advanced, lance in hand, and then stood still waiting "for the creature's assault. I must say I trembled for him, and loaded "my gun with two balls; but when the rhinoceros came within reach, "and opened his immense jaws to seize his enemy,§ the hunter thrust "his lance into him to a depth of some feet, and calmly retired to "where we were posted." After the animal was dead, the chief withdrew his sword-fish blade, and presented it to Mons. Mouhot.

The narwhal has a still more formidable weapon of the same kind (Fig. 50). It attacks the whale, and occasionally the bottoms of ships a specimen of the effect of which attack, from the Museum of the Institution, is now exhibited (Fig. 51). The Esquimaux, who, in the accounts of which they give of their own customs, profess to derive much experience from the habits of the animals amongst which they live, use the narwhal's tusk for the points of their spears. Fig. 52

* Beechey's Voyage to the North Pole, pp. 91, 94.

† Bates—Naturalist on the Amazons, vol. ii, 141.

‡ Travels in the central parts of Indo-China, Siam, Cambodia, and Laos, in 1858–9, by the late M. Henri Mouhot, vol. ii, p. 147.

§ It is to be observed that this is not the rhinoceros's usual mode of attack.

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represents a nuguit from Greenland, of the form mentioned by Crantz; it is armed with the point of the narwhal's tusk. Fig. 53, from my collection, has the shaft also of narwhal's tusk; it is armed with a metal blade, but it is introduced here in order to show the association which existed in the mind of the constructor between his weapon and the animal from which the shaft is derived, and for the capture of which it is chiefly used. The wooden shaft, it will be seen, is constructed in the form of the fish, and the ivory fore shaft is inserted in the snout in the exact position of that of the fish itself. At Kotzebue Sound Captain Beechey* found the natives armed with lances composed of a walrus tooth fixed to the end of a wooden staff (Fig. 54). They also employ the walrus tooth for the points of their tomahawks (Fig. 55). The horns of the antelope are used as lance points by the Djibba negroes of Central Africa, as already mentioned, and in Nubia also by the Shillooks and Dinka.† The antelope's horn is also used in South Africa for the same purpose.‡ The argus pheasant of India,§ the wing-wader of Australia,‖ and the plover of Central Africa,¶ have spurs on their wings, with which they fight; the cock and turkey have spurs on their feet, used expressly for offence. The white crane of America has been known to drive its beak deep into the bowels of a hunter.** The Indians of Virginia, in 1606, are described as having arrows armed with the spurs of the Turkey, and beaks of birds††. In the Christy collection there is an arrow supposed to be from South America, which is armed with the natural point of the deer's horn (Fig. 56). The war club of the Iroquois, called GA-NE-U-GA-O-DUS-HA, or "deer-horn war club," was armed with a point of the deer's horn (Fig. 57), about 4 inches in length; since communication with Europeans, a metal point has been substituted (Fig. 58). It appears highly probable that the martel-de-fer of the 15th and 16th centuries, and which is also used in India and Persia, may have been derived, as its form indicates, from a horn weapon of this kind. Horn points suitable for arming such weapons have been found both in England and Ireland, two specimens of which are in my collection.‡‡ The weapon of the sting ray, from the method of using it by the animal itself, should more properly be classed with serrated weapons, but it is a weapon in general use amongst savages for spear or arrow points (Fig. 59), for which it has the particular merit of breaking off in the wound. It causes a frightful wound, and being sharply serrated, as well as pointed, there is no means of cutting it out. It is used in this way

* Beechey's Voyage, p. 252.
† Journal of the Archæological Association, vol. iii, p. 25.
‡ Ibid. vol. iii, p. 26.
§ Swainson's Habits and Instincts of Animals, p. 141.
‖ Gregory's Expedition to the North-west Coast of Australia, vol. 32—Royal Geographical Society's Journal.
¶ Denham and Clapperton's Travels, p. 20.
** Narrative of the Canadian Exploring Expedition, by G. H. Hind, p. 316.
†† Captain John Smith's Sixth Voyage to Virginia in 1606; Pinkerton, vol. xiii, p. 36.
‡‡ See Cuming on Weapons of Horn, Journal of the British Archæological Association, vol. iii, p. 27.

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by the inhabitants of Gambier Island, Samoa,* Otaheite,† the Fije Islands,‡ Pellew Islands,§ and many of the low islands. Amongst the savages of tropical South America, the blade of the ray, probably the trygon histrix, is used for arrow points.‖

In the "Balistes capriscus" (Fig. 60*a*) a rare British fish, the anterior dorsal, is preceded by a strong erectile spine, which is used for piercing other fishes from beneath. Its base is expanded and perforated, and a bolt from the supporting plate passes freely through it. When this spine is raised, a hollow at the back receives a prominence from the next bony ray, which fixes the spine in an erect position, as the hammer of a gun-lock acts at full cock, and the spine cannot be forced down till this prominence is withdrawn, as by pulling the trigger, "This "mechanism may be compared to the fixing and unfixing of a "bayonet; when the spine is unfixed and bent down, it is received "into a groove on the supporting plate, and offers no impediment to "the progress of the fish through the water." These fishes are also found in a fossil state, and to use the words of Professor Owen, from whose work this description of the Balistes is borrowed: "exemplify "in a remarkable manner the efficacy, beauty, and variety of the ancient "armoury of that order."¶ The stickleback is armed in a similar manner, and is exceedingly pugnacious. The Cottus diceraus, Pall., (Fig. 60*b*) has a multi-barbed horn on its back, exactly resembling the spears of the Esquimaux, South American, and Australian savages. The Nascus fronticornis, Lac., (Fig. 60*c*) has also a spear-formed weapon. The Yellow-bellied acanthurus is armed with a spine of considerable length upon its tail.

The Australians of King George's Sound used the pointed fin of the roach to arm their spears,** the inhabitants of New Guinea also arm their arrows with the offensive horn of the saw-fish, and with the claw of the cassowary. The sword of the limulus, or king-crab, is an offensive weapon; its habits do not appear to be well understood, but its weapon is used in some of the Malay islands for arrow points (Fig. 61). The natives of San Salvador, when discovered by Columbus, used lances pointed with the teeth of fish.†† The spine of the Diodon is also used for arrow points (Fig. 62). Amongst other piercing weapons suggested by the horns of animals, may be noticed, the Indian kandjar composed of one side of the horn of the buffalo, having the natural form and point (Fig. 63). In later times a metal dagger, with ivory handle was constructed in the same country (Fig. 64), after the exact model of the one of horn, the handle having one side flat, in imitation of the half-split horn, though of course that peculiar form was no longer necessitated by the material then used. The same form of weapon was afterwards used with a metal handle (Fig 65).

* Nineteen Years in Polynesia, Turner, p. 276.
† Beechey's Voyage to the Pacific, vol. i, ch. vi.
‡ Fije and the Fijeans, by T. Williams, Missionary, vol. i, ch. iii.
§ Wilson's Pellew Islands, Keate, pl. v.
‖ Klemm Wertzenge und Waffen, p. 48.
¶ Comparative Anatomy and Physiology of Vertebrates, Owen, vol. i, p. 186.
** Klemm, p. 31
†† Pre-historic Man, vol. i, p. 145.

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The sharp horns of the sasin, or common antelope, often steel pointed, are still used as offensive weapons in India (Figs. 66, 67, 68). Several examples of these are in the Museum of the Institution. Three stages of this weapon are exhibited, the first having the natural point, the second a metal point, and the third a weapon of nearly the same form composed entirely of metal. The Fakirs and Dervish's, not being permitted by their profession to carry arms, use the pointed horn of the antelope for this purpose. Fig. 69 is a specimen from my collection; from its resemblance to the Dervish's crutch of Western Asia, I presume it can be none other than the one referred to in the Journal of the Archæological Association, from which I obtained this information respecting the Dervish's weapon.* Mankind would also early derive instruction from the sharp thorns of trees, with which he must come in contact in his rambles through the forests, the African mimosa, the gledischia, the American aloe, and the spines of certain palms, would afford him practical experience of their efficacy as piercing weapons, and accordingly we find them often used by savages in barbing their arrows.†

Striking Weapons.—Many animals defend themselves by blows delivered with their wings or legs; the giraffe kicks like a horse as well as strikes side-ways with its blunt horns; the camel strikes with its fore legs and kicks with its hind legs; the elephant strikes with its proboscis and tramples with its feet; eagles, swans, and other birds strike with their wings; the swan, is said to do so, with sufficient force to break a man's leg; the cassowary strikes forward with its feet; the tiger strikes a fatal blow with its paw; the whale strikes with its tail, and rams with such force that the American whaler "Essex," is said to have been sunk by that animal.‡ There is no known example of mankind in so low a state as to be unacquainted with the use of artificial weapons. The practice of boxing with the fist, however, is by no means confined to the British Isles as some people seem to suppose, for besides the Romans, Lusitanians,§ and others mentioned in classical history, it prevailed certainly in the Polynesian islands‖ and in Central Africa.¶

Serrated Weapons.—This class of weapons in animals corresponds to the cutting weapons of men. Amongst the most barbarous races, however, as amongst animals, no example of a cutting weapon is found,**

* Journal of the Archæological Association, vol. iii, p. 26—Cuming on Weapons of Horn.

† The probability of the aboriginal man having derived his first lessons from this source may be judged of by the accounts given by travellers of the effects produced by the large thorns of trees in South Africa, of which there is a good account in Routledge's Natural History of Man, by the Rev. J. G. Wood, chap. xxi, Kaffir. Large animals are said to be frequently destroyed, and even to have impaled themselves upon the large, strong spines of the thorny Acacia. Throughout Central Africa a pair of tweezers for extracting thorns is an indispensable requisite in the equipment of every native.

‡ Beechey's Voyage to the Pacific, vol. i, p. 47.

§ Strabo, b. iii, c. iii. ‖ Ellis's Polynesian Researches, chap. viii.

¶ Clapperton's Travels, p. 58.

** I exclude from this category all nippers, cross bills, and prehensile implements.

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although the Polynesian islanders make very good knives of the split and sharpened edges of bamboo, and the Esquimaux, also, use the split tusk of the walrus as a knife, they cannot be regarded, nor, indeed, are they used, as edged weapons. These, strictly speaking, are confined to the metal age, and their place, in the earliest stages of civilization, are supplied by weapons with serrated, or saw-like edges.

Perhaps the nearest approach in the animal kingdom to an edged weapon is the fore-arm of the mantis, a kind of cricket, used by the Chinese and others in the East for their amusement. Their combats have been compared to that of two soldiers fighting with sabres. They cut and parry with their fore-arms, and, sometimes, a single stroke with these is sufficient to decapitate or cut in two, the body of an antagonist. But, on closer inspection, these fore-arms are found to be set with a row of strong and sharp spines, similar to those of all other animals that are provided with this class of weapon. The snout of the saw-fish is another example of the serrated weapon. Its mode of attacking the whale is by jumping up high in the air, and falling on the animal, not with the point, but with the sides of its formidable weapon, both edges of which are armed with a row of sharp horns, set like teeth, by means of which it rasps a severe cut in the flesh of the whale. The design in this case is precisely analogous to that of the Australian savage, who throws his similarly constructed spear so as to strike, not with the bone point, but with its more formidable edges, which are thick set with a row of sharp-pointed pieces of obsidian, or rock-crystal. The saw-fish is amongst the most widely distributed of fishes, belonging to the arctic, antarctic, and tropical seas. It may, therefore, very possibly have served as a model in many of the numerous localities in which this character of weapon is found in the hands of savages. The snout itself is used as a weapon by the inhabitants of New Guinea, the base being cut and bound round so as to form a handle. Plate LIII, fig. 70, is a specimen from the Museum of the Institution. The weapon of the sting ray, though used by savages for spear-points, more properly belongs to this class, as the mode of its employment by the animal itself consists in twisting its long, slender tail round the object of attack, and cutting the surface with its serrated edge.* The teeth of all animals, including those of man himself, also furnish examples of serrated weapons.

When we find models of this class of weapon so widely distributed in the lower creation, it is not surprising that the first efforts of mankind in the construction of trenchant implements, should so universally consist of teeth or flint flakes, arranged along the edges of staves or clubs, in exact imitation of the examples which he finds ready to his hand, in the mouths of the animals which he captures, and on which he is dependent for his food. Several specimens of implements, edged in this manner with sharks' teeth, from the Museum of the Institution, are now exhibited (Figs. 71, 72, 73, 74). They are found chiefly in the Marquesas, in Tahite, Depeyster's Island, Byron's Isles, the King's Mill group, Radact Island†, and the Sandwich Islands‡, also in New

* Naturalist's Library, vol. iii, p. 335.

† Voyage Pictoresque Autour du Monde, par M. Louis Choris, peintre 1822.

‡ Cook's Third Voyage.

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Zealand (Fig. 75). They are of various shapes, and used for various cutting purposes, as knives, swords, and glaves. Two distinct methods of fastening the teeth to the wood prevail in the Polynesian Islands; firstly, by inserting them in a groove cut in the sides of the stick or weapon, and, secondly, by arranging the teeth in a row, along the sides of the stick, between two small strips of wood on either side of the teeth, lashed on to the staff, in all cases, with small strings, composed of plant fibre. The points of the teeth are usually arranged in two opposite directions on the same staff, so that a severe cut may be given either in thrusting or withdrawing the weapon.*

A similarly constructed implement, also edged with sharks' teeth, was found by Captain Graah, on the east coast of Greenland, and is mentioned in Dr. King's paper on the industrial arts of the Esquimaux, in the Transactions of the Ethnological Society.† The teeth in this implement were secured by small nails, or pegs of bone; it was also used formerly on the West Coast. A precisely similar implement (Fig. 76), but showing an advance in art by being set with a row of chips of meteoric iron, was found amongst the Esquimaux of Davis Strait, and is now in the department of meteorolites in the British Museum. Others, of the same nature, from Greenland, are in the Christy collection (Fig. 77). The pacho, of the South Sea Islands, appears to have been a sort of club, armed on the inner side with shark's teeth, set in the same manner.‡ The Tapoyers, of Brazil, used a kind of club, which was broad at the end, and set with teeth and bones, sharpened at the point.§

Hernandez gives an account of the construction of the Mexican Maquahuilt or Aztec war club, which was armed on both sides with a row of obsidian flakes, stuck into holes, and fastened with a kind of gum‖ (Fig. 78). Herrera, the Spanish historian, also mentions these as swords of wood, having a groove in the fore part, in which the flints were strongly fixed with bitumen and thread.¶ In 1530, according to the Spanish historians, Copan was defended by 30,000 men, armed with these weapons, amongst others;** and similar weapons have been represented in the sculptures of Yucatan.†† They are also represented in Lord Kingsborough's important work on Mexican Antiquities, from which the accompanying representations are taken (Figs. 78, 79, 80). One of these swords, having six pieces of obsidian on each side of the blade, is to be seen in a Museum in Mexico.

In the burial mounds of Western North America, Mr. Lewis Morgan, the historian of the Iroquois, mentions that rows of flint flakes have been found lying, side by side, in order, and suggesting the idea

* Klemm, ; Wilkes's United States Exploring Expedition, vol. v, ch. ii.

† Trans. Ethnol. Soc., vols. i–ii, p. 290.

‡ Ellis's Polynesian Researches, chaps. xi, xii.

§ Menhoff—Travels in Brazil; Pinkerton, vol. xiv, p. 874.

‖ Tylor—Anahuac, Appendix.

¶ Pre-historic Man, vol. i, p. 216, 217.

** Incidents of Travel in Central America, by J. Lloyd Stephens, p. 51.

†† Pre-historic Man, vol. i, p. 226, 227.

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that they must have been fastened into sticks in the same manner as those of Mexico and Yucatan.

Throughout the entire continent of Australia the natives arm their spears with small sharp pieces of obsidian, or crystal, and recently of glass, arranged in rows along the sides near the point, and fastened with a cement of their own preparation, thereby producing a weapon which, though thinner in the shaft, is precisely similar in character to those already described (Figs. 81 and 82). Turning again to the northern hemisphere, we find in the Museum of Professor Nilsson, at Lund, in Sweden, a smooth, sharp-pointed piece of bone, found in that country, about six inches long, grooved on each side to the depth of about a quarter of an inch, into each of which grooves a row of fine, sharp-edged, and slightly-curved flints were inserted, and fixed with cement. The instrument thus armed was fastened to the end of a shaft of wood, and might either have been thrown by the hand or projected from a bow (Fig. 83). Another precisely similar implement (Fig. 84) is represented in the illustrated catalogue of the Museum at Copenhagen, showing that in both these countries this system of constructing trenchant implements was employed. In Ireland, although there is no actual evidence of flints having been set in this manner, yet from the numerous examples of this class of weapon that are found elsewhere, and the frequent occurrence of flint implements of a form that would well adapt them to such a purpose, the author of the Catalogue of the Royal Irish Academy expresses his opinion that the same arrangement may very possibly have existed in that country, and that the wood in which they were inserted may, like that which, as I have already said, is supposed to have held the flints found in the graves of the Iroquois, have perished by decay.

Poisoned Weapons.—It is unnecessary to enter here into a detailed account of the use of poison by man and animals. Its use by man as a weapon of offence is chiefly confined to those tropical regions in which poisonous herbs and reptiles are most abundant. It is used by the Negroes, Bushmen, and Hottentots of Africa; in the Indian Archipelago, New Hebrides, and New Caledonia. It appears formerly to have been used in the South Seas. It is employed in Bootan, Assam, by the Stiens of Cambodia, and formerly by the Moors of Mogadore. The Parthians and Scythians used it in ancient times; and it appears always to have been regarded by ancient writers as the especial attribute of barbarism. The Italian bravoes of modern Europe also used it. In America it is employed by the Darian Indians in Guiana, Brazil, Peru, Paraguay, and on the Orinoco. The composition of the poison varies in the different races, the Bushmen and Hottentots using the venomous secretions of serpents and caterpillars,* whilst most other nations of the world employ the poisonous herbs of the different countries they locate, showing that in all probability this must have been one of those arts which, though of very early origin, arose spontaneously and separately in the various quarters of the globe, after the human family had separated. This subject, however,

* Thernberg's Account of the Cape of Good Hope—Livingstone.

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is deserving of a separate treatment, and will be alluded to elsewhere.

In drawing a parallel between the weapons of men and animals used in the application of poison for offensive purposes, two points of similitude deserve attention.

Firstly. The poison gland of many serpents is situated on the upper jaw, behind and below the eyes. A long excretory duct extends from this gland to the outer surface of the upper jaw, and opens above and before the poison teeth, by which means the poison flows along the sheath into the upper opening of the tooth in such a manner as to secure its insertion into the wound. The hollow interior of the bones with which the South American and other Indians arm their poisoned arrows secures the same object (Fig. 85); it contains the poisonous liquid, and provides a channel for its insertion into the wound. In the bravo's daggers of Italy, a specimen of which from my collection is exhibited (Fig. 86), a similar provision for the insertion of the poison is effected by means of a groove on either side of the blade, communicating with two rows of small holes, into which the poison flows, and is retained in that part of the blade which enters the wound. Nearly similar blades, with holes, have been found in Ireland, of which a specimen is in the Academy's Museum, and they have been compared with others of the same kind from India, but I am not aware that there is any evidence to show that they were used for poison. Some of the Indian daggers, however, are constructed in close analogy with the poison apparatus of the serpent's tooth, having an enclosed tube running down the middle of the blade, communicating with a reservoir for poison in the handle, and having lateral openings in the blade for the diffusion of the poison in the wound. Similar holes, but without any enclosed tube, and having only a groove on the surface of the blade to communicate with the holes, are found in some of the Scotch dirks, and in several forms of *couteau de chasse*, in which they appear to have been used merely with a view of letting air into the wound, and accelerating death (Figs. 87*a* and *b*). The Scotch dirk, here represented, has a groove running from the handle along the back of the blade to within three and-a-half inches of the point. In the bottom of this groove ten holes are pierced, which communicate with other lateral holes at right angles, opening on to the sides of the blade. Daggers are still made at Sheffield for the South American market, with a small hole drilled through the blade, near the point, to contain the poison, and in my collection there is an iron arrow-point (Fig. 88), evidently formed of the point of one of these daggers, having the hole near the point.

It often happens that forms which, in the early history of an art, have served some specific object, are in later times applied to other uses, and are ultimately retained only in the forms of ornamentation. This seems to have been the case with the pierced work upon the blades of weapons which, intended originally for poison, was afterwards used as air-holes, and ultimately for ornament only, as appears by a plug bayonet of the commencement of the eighteenth century in the Tower Armoury, No. 390 of the official Catalogue, for a drawing of which, as

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well as that of the Scotch dirk, I am indebted to Captain A. Tupper, member of the Council of this Institution.

The second point of analogy to which I would draw attention is that of the multi-barbed arrows of most savages to the multi-barbed stings of insects, especially that of the bee (Fig. 89), which is so constructed that it cannot usually be withdrawn, but breaks off with its poisonous appendage into the wound. An exact parallel to this is found in the poisoned arrows of savages of various races, which, as already mentioned, are frequently armed with the point of the sting ray, for the express purpose of breaking into the wound. In the arrows of the Bushmen, the shaft is often partly cut through, so as to break when it comes in contact with a bone, and the barb is constructed to remain in the wound when the arrow is withdrawn (Fig. 90). The same applies to the barbed arrows used with the Malay blowpipe (Fig. 91), and those of the wild tribes of Assam (Fig. 92), which are also poisoned. The arrow points of the Shoshones of North America (Fig. 93), said to be poisoned, are tied on purposely with gut in such a manner as to remain when the arrow is withdrawn. The arrows of the Macoushie tribe of Guiana (Fig. 94) are made with a small barbed and poisoned head, which is inserted in a socket in the shaft, in which it fits loosely, so as to detach in the wound. This weapon appears to form the link between the poisoned arrow and the fishing arrow or harpoon, which is widely distributed, and which I propose to describe on a subsequent occasion. Mr. Latham, of Wilkinson's, Pall Mall, has been kind enough to describe to me a Venetian dagger of glass, formerly in his possession; it had a tube in the centre for the poison, and the blade was constructed with three edges. By a sharp wrench from the assassin, the blade was broken off, and remained in the wound.

It has also been supposed that from their peculiar construction most of the triangular and concave-based arrow heads of flint that are found in this country and in Ireland were constructed for a similar purpose (Fig. 95).

The serrated edges of weapons, like those of the bee, and the sting-ray when used as arrow points, were likewise instrumental in retaining the poison and introducing it into the wound, and this form was copied with a similar object in some of the Florentine daggers above mentioned, a portion of the blade of one of which, taken from Meyrick's ancient arms and armour, is shewn in Fig. 96.*

Although the use of poison would in these days be scouted by all civilised nations as an instrument of war, we find it still applied to useful purposes in the destruction of the larger animals. The operation of whaling, which is attended with so much danger and difficulty, has of late been greatly facilitated by the use of a mixture of strychnine, and woorali the well-known poison of the Indians of South America. An ounce of this mixture, attached to a small explosive shell fired from a carbine, has been found to destroy a whale in less than eighteen minutes, without risk to the whaler.†

* Meyrick—Ancient Arms and Armour, vol. ii, Pl. cxiii, figs. 7, 13, 14.

† *Times* newspaper, 24th December, 1866.

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When we consider how impotent a creature the aboriginal and uninstructed man must have been when contending with the large and powerful animals with which he was surrounded, we cannot too much admire that provision of nature which appears to have directed his attention, during the very earliest stages of his existence, to the acquirement of the subtile art of poisoning. In the forests of Guiana there are tribes, such as the Otomacs, apparently weaponless, but which, by simply poisoning the thumb nail with curare or woorale, at once become formidable antagonists.* Poison is available for hunting as well as for warlike purposes: the South American Indians eat the monkeys killed by this means, merely cutting out the part struck,† and the wild tribes of the Malay peninsula do not even trouble themselves to cut out the part before eating.‡ The Bushmen, and the Stiens of Cambodia use their poisoned weapons chiefly against wild beasts and elephants.

Thus we see that the most noxious of herbs, and the most repulsive of reptiles have been the means ordained to instruct mankind in what, during the first ages of his existence, must have been the most useful of arts. We cannot now determine how far this agent may have been influential in exterminating those huge animals, the elephas primigenius and rhinoceros tichorhinus, with the remains of which the earliest races of man have been so frequently associated, and which, in those primeval days, before he began to turn his hand to the destruction of his own species, must have constituted his most formidable enemies.

Missiles.—Amongst the offensive weapons of animals, the use of missiles cannot be altogether excluded, although the examples of its use by the lower creation are extremely rare. Some species of cuttle-fish have the power of ejecting water with a good aim.§ The toxotes, or archer-fish, obtains its name from its faculty of projecting drops of water at insects some three or four feet from the surface of the water, and which it seldom fails to bring down. The llama has a habit of ejecting its saliva, but I am not aware of the object of this singular practice. I only know from experience that its manners are offensive, and that it has the power of spitting with a good aim and for some distance. The porcupine has the power of throwing its quills, and is said to do so with effect, although it is not now believed to dart them with any hostile intention. The Polar bear is described in Captain Hall's recent publication as an animal capable of capturing the walrus by missile force. It is said that the bear will take advantage of an overhanging cliff, under which its prey is seen asleep upon the ice, to throw down with its paws, large stones, and with such good aim as to hit the walrus on the head, after which, running down to the place where the animal lays stunned, it will take the stone to beat out its brains. That animals are instinctively acquainted with the force of gravitation is evident by their avoiding precipices that would endanger

* Humboldt's Aspects of Nature, vol. i, pp. 25 and 103.

† Klemm.

‡ On the Wild Tribes in the Interior of the Malay Peninsula, by Père Bourien. Trans. Ethno. Soc., vol. iii, p. 78.

§ Darwin's Naturalist's Journey, p. 8.

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them, and it certainly requires a slight, but at the same time most important advance upon this knowledge to avail themselves of large stones for such purposes as are here attributed to the bear; but as the story only rests on the authority of the Esquimaux, it must, I think—although they certainly are careful observers of the habits of animals—be rejected, until confirmed by the direct testimony of white men. It has even been doubted whether the alleged habit of monkeys in throwing cocoa-nuts at their pursuers, has not arisen from the mistake of the hunter in supposing that fruit accidentally detached from their stalks by the gambols of these animals in the trees, may have been intended as missiles, but it appears now to be clearly established that monkeys have the intelligence, not only to throw stones, but even to use them in breaking the shells of nuts. Major Denham, in his account of his travels in Central Africa, near Lake Tshad, says:—"The monkeys, or "as the Arabs say, men enchanted, 'Beny Adam meshood,' were so "numerous, that I saw upwards of 150 assembled in one place in the "evening. They did not appear at all inclined to give up their ground. "but perched on the top of a bank, some 20 feet high, made a terrible "noise, and rather gently than otherwise, pelted us as we approached "within a certain distance." This, I think, is clear evidence of a combined pelting on the part of these untutored animals.

The monkey thus furnishes us with the only example of the use of any external substance for offensive purposes, by any member of the animal kingdom. All others, except, perhaps, the missile fishes above described, use, for offence and defence, the weapons with which nature has furnished them, and which are integral parts of their persons. It is this which so essentially distinguishes man from the lower creation. Man is the tool-using animal. We have no knowledge of man, in any state of existence, who is not so; nor have we (with the exception of the ape, the link indirectly connecting him with the lower creation, in the same manner that the savage connects the civilized with the aboriginal man, both being branches from the same stem) any knowledge of animals that employ tools or weapons. Herein lies the point of separation, which, in so far as the material universe is concerned, marks the dawn of a new dispensation. Hitherto Providence operates directly on the work to be performed, by means of the living, animated tool. Henceforth, it operates indirectly on the progress and development of creation, first, through the agency of the instinctively tool-using savage, and by degrees, of the intelligent and reasoning man.

DESCRIPTION OF THE PLATES.

Plate XLVIII, fig. 1 (*a*).—Adze of iron, constructed by Captain Cook's armourer, for the use of the natives of Tahiti, after the model of their own—(*b*) of stone.

Plate XLVIII, fig. 2 (*a*).—A pipe-handled Tomahawk, of European manufacture, constructed for the North American Indians. Museum of the Royal United Service Institution.—Engraved Illustrations of Ancient Armour. Meyrick. Vol. 2, plate cxlix.—(*b*) a Pipe and Tomahawk of pipe stone used by the

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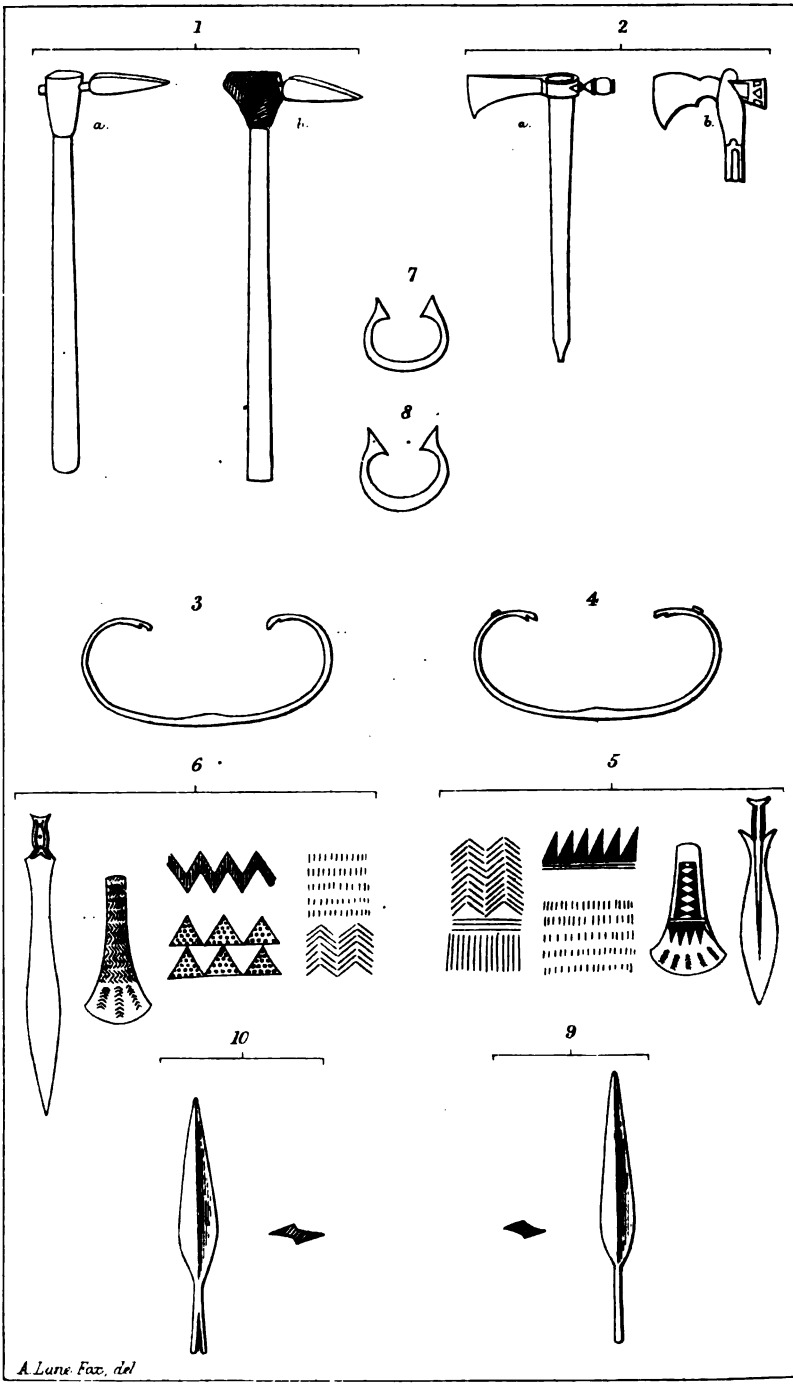

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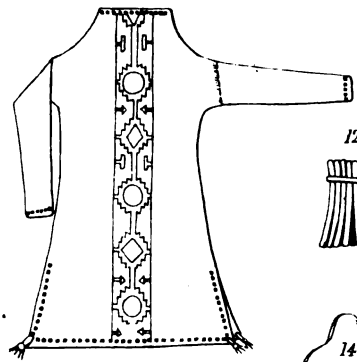
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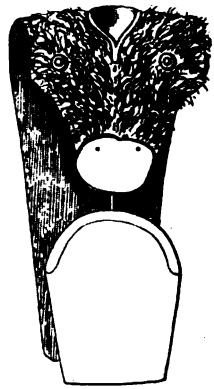

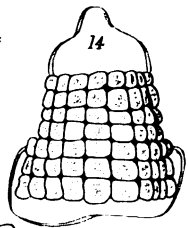
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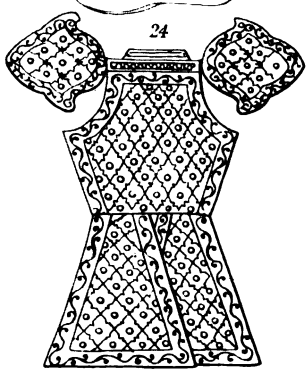
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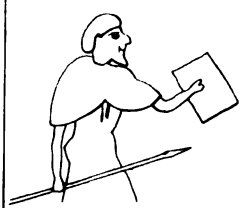
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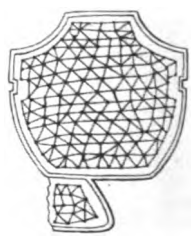
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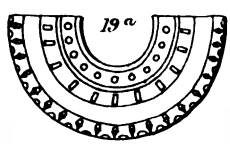
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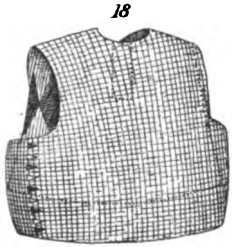

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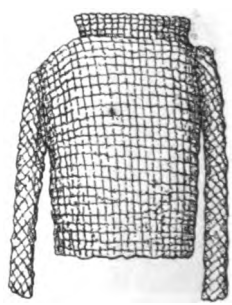

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Dacotas of North America—Schoolcraft. History of the Condition and Prospects of the Indian Tribes of the United States, Vol. 2, plate lxix.

Plate XLVIII, fig. 3.—A Mœotian, or Scythian Bow, from a fictile vase, represented in Hamilton's Etruscan Antiquities, Vol. 4, plate cxvi.—Critical Enquiry into Ancient Armour. Meyrick, Vol. 1, plate ii.—See also Rawlinson's Herodotus, Vol. 1.

Plate XLVIII, fig. 4.—Bow of the Tartar Tribes on the borders of Persia.—Engraved Illustrations of Ancient Armour. Meyrick, Vol. 2, plate cxliv.—Museum of the Royal United Service Institution.

Plate XLVIII, fig. 5.—Iron Sword of native manufacture, minus the wooden handle, and War Axe, both constructed by the Fans of the Gaboon country, West Africa. From Colonel Lane Fox's Collection. A nearly similar axe is in the Museum of the Royal United Service Institution. The patterns of ornamentation are taken, partly from the Fan War Axe, and partly from some knives of iron brought from Central Africa, by Mr. Petherick, and now in Colonel Fox's Collection.

Plate XLVIII, fig. 6.—Leaf-shaped Bronze Sword, minus the handle, from Ireland. Col. Fox's Collection.—A Bronze Celt, in the Museum at Maintz.—Die Alterthümer unserer heidnischen Vorzeit. L. Lindenschmit. The patterns of ornamentation are taken partly from Lindenschmit, Plate iii, and partly from illustrations of Irish bronze ornamental work in the Illustrated Catalogue of the Royal Irish Academy, by R. W. Wilde, M.D., M.R.I.A. Bronze, pp. 389, 390.

Plate XLVIII, fig. 7.—A Manilla, or specimen of the ring money of copper and iron, used as a medium of exchange in the Eboe country, West Africa. From Colonel Lane Fox's Collection.—In 1836, a ship laden with a quantity of these Manillas, made in Birmingham, after the pattern in use in Africa (the specimen here figured forming part of the cargo), was wrecked on the coast of the county of Cork. By this means their exact resemblance to the gold and bronze Penanular rings found in Ireland (Fig. 8), attracted the notice of Mr. Sainthill, of Cork, by whom the subject was communicated to the *Ulster Journal of Archæology*, No. 19, July, 1857.

Plate XLVIII, fig. 8.—A Penanular Ring, found in Ireland. Wilde's Catalogue of the Royal Irish Academy. Bronze, p. 570. Gold, p. 53.—Similar forms are found in England, and on the Continent. Linderschmit Tafel iv; Keller, Plate lii *a*, fig. 9.

Plate XLVIII, fig. 9.—A Caffre Assegai-head of Iron, of native manufacture, with section of blade. Museum of Royal United Service Institution.

Plate XLVIII, fig. 10.—A Saxon Spear-head of Iron, having the same sectional form as Fig. 9. Found in the Saxon graves.—Neville's Saxon Obsequies.—Akerman's Pagan Saxendon.

Plate XLIX, fig. 11.—War Dress of a Patagonian Chief, composed of seven thicknesses of hide on the body part, and three on the sleeves.—Museum of the Royal United Service Institution.

Plate XLIX, fig. 12.—Section of the above armour upon the breast, showing the manner in which the seven thicknesses are united at top.

Plate XLIX, fig. 13.—Kayan Cuirass and Helmet. The helmet of cane wickerwork. The cuirass of untanned hide, having the hair on the outside.—Museum of the Royal United Service Institution, presented by Captain D. Bethune, R.N.

Plate XLIX, fig. 14.—An Egyptian Breast-plate, made of a crocodile's back.—Engraved Illustrations of Ancient Armour. Meyrick, Skelton, Vol. 2, plate cxlviii.

Plate L, fig. 15.—A suit of Armour, supposed formerly to have belonged to the Rajah of Guzerat. The four breast and back pieces are of rhinoceros hide, having an inscription upon them, beginning with an invocation to Ali. The remaining portions are of black velvet, ornamented with brass studs, and padded.—Engraved illustrations of Ancient Armour. Meyrick, Skelton. Vol. 2, plate cxli.

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Plate L, fig. 16.—Four plates of steel, of similar form to those of rhinoceros hide in the preceding figure. They are fastened with straps over a coat of chain armour, and are called, in the Persian language, "char aineh," *i. e.* "the four mirrors." They are ornamented with patterns of inlaid gold.—Museum of the Royal United Service Institution.

Plate L, fig. 17.—A Helmet of Basketwork, from the Sandwich Islands, resembling the Grecian in form.—Museum of the Royal United Service Institution, presented by H. Shelley, Esq.

Plate XLIX, fig. 18.—A Suit of Armour of cocoa-nut fibre, from Pleasant Island, in the Pacific ocean.—Museum of the Royal United Service Institution, presented by Colonel Sir G. Arthur. It is probable that the under tippet, which is now attached to the back and breast piece at the top, may originally have been intended to be worn round the loins, like a kilt.

Plate XLIX, fig. 19 (*a*).—Quilted Pectoral of the Egyptians.—Critical Enquiry into Ancient Armour. Meyrick, Vol 1, plate i.—(*b*) shows the manner in which it was worn, and is taken from a figure in Rawlinson's Herodotus.

Plate L, fig. 20.—Quilted Head-dress of the Egyptian Soldiers.—Critical Enquiry into Ancient Armour. Meyrick, Vol. 1, plate i.

Plate L, fig. 21.—Quilted Helmet of nearly the same form as the above, from India. Colonel Fox's Collection.

Plate L, fig. 22.—A Head-dress of nearly the same form as figs. 20 and 21, belonging to the Nouaer tribe of Negroes, inhabiting both sides of the Nile from 8° to 10° N. latitude, brought to England by Mr. Petherick, and now in Colonel Fox's Collection. It resembles the Egyptian very closely, and is composed of cylindrical white beads, fastened together with a kind of string. The beads are of European manufacture.

Plate L, fig, 23.—A Helmet of the same form as fig. 21, composed of united mail and plate, formerly belonging to the Body Guard of the Moguls.—Colonel Fox's Collection.

Plate XLIX, fig. 24.—A Suit of Quilted Armour, taken in action from Koer Singh, the famous Rajpoot Chief, of Jugdespore in Behar, on the 12th of August, 1857, by Major Vincent Eyre, commanding the field force that relieved Arrah.—Museum of the Royal United Service Institution, presented by Major-General Sir Vincent Eyre, K.C.S.I., C.B.

Plate LI, fig. 25 (*a*).—Suit of Quilted Armour, found upon the body of Tippoo Saib at his death, in the breach of Seringapatam. Upon the breast, this armour consists of two sheets of parchment, and nine thicknesses of quilting, composed of cocoons of the "Saturnia Mylitta," stuffed with the wool of the "Eriodendron Anfractuosum, D.C.," a jungle plant, and neatly sown together, as represented in fig. 25 (*b*).—Museum of the Royal United Service Institution.

Plate LI, fig. 25 (*b*).—A portion of one of the nine thicknesses of quilting of the above, reduced to ½th the natural size.

Plate LI, fig. 25 (*c*).—Tippoo Saib's Helmet; belongs to the above suit.—Museum of the Royal United Service Institution.

Plate L, fig. 26.—Quilted Armour of the Bornouese Cavalry.—Travels of Denham and Clapperton.

Plate XLIX, fig. 27.—A Suit of Armour from the Navigator's Islands, composed of cocoa-nut fibre, coarsely netted.—Museum of the Royal United Service Institution; presented by Sir W. Burnett, M.D.—Similar armour is used in the King's Mill Group.

Plate XLIX, fig. 28.—Part of a Chinese Brigandine Jacket of cotton, quilted with enclosed plates of metal.—Museum of the Royal United Service Institution.

Plate L, fig. 29.—Head-dress of Hercules wearing the Lion's Skin, from a Bronze in the Blacas Collection, British Museum.

Plate L, fig. 30.—Head-dress of a North American Indian Chief.—Schoolcraft. History, condition, and prospects of the Indian Tribes, Vol. iii, p. 68 plate x.

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Plate L, fig. 31.—Thracian Helmet of Brass, with horns of the same—Critical Enquiry into Ancient Armour. Meyrick, Vol. 1, plate iii.

Plate L, fig. 32.—Ancient British Helmet of Bronze, with straight horns of the same, found in the Thames.—British Museum.

Plate L, fig. 33.—Greek Helmet, having horns of brass.—Critical Enquiry into Ancient Armour. Meyrick, Vol. 1, plate iv.

Plate LI, fig. 34.—Back and Breast-piece of the Bugo Dyaks, armed with the Scales of the Pangolin.—Museum of the Royal United Service Institution.

Plate L, fig. 35.—A piece of Bark from Tahiti, studded with pieces of cocoa-nut shell.—Museum of the Royal United Service Institution.

Plate L, fig. 36.—Fragment of Scale Armour of Horn, found at Pompeii.—Pictorial Gallery of Arts, Vol. 1, figs. 10, 61.

Plate L, fig. 37.—A piece of Scale Armour, made of the hoofs of some Animal, from some part of Asia; said to be from Japan.—Critical Enquiry into Ancient Armour.—Meyrick, Vol. 1, plate iii.

Plate LI, fig. 38.—An ancient Stone Figure in scale armour, having an inscription in a character cognate to the Greek, but in an unknown language.—Cuming on Weapons of Horn, Journal of the Archæological Association, vol. iii.

Plate L, fig. 39.—Back and Breast-piece of Armour from the Sandwich Islands, composed of seal's teeth.—Museum Royal United Service Institution; presented by H. Shelley, Esq.

Plate LI, fig. 40.—An Egyptian Suit of Scale Armour.—Rawlinson's Herodotus.—See also Sir Gardiner Wilkinson.

Plate LI, fig. 41.—Two Scales of Egyptian Scale Armour, enlarged.—Rawlinson's Herodotus.

Plate LI, fig. 42.—Japanese Armour, composed of chain, plate, and enclosed quilted plates.—Colonel Fox's Collection.—(*a*) Left arm; (*b*) Greaves.

Plate LI, fig. 43 (*a*).—A Suit of Chinese Armour of cotton, having iron scales attached to the inside.—Museum Royal United Service Institution; presented by Captain Sir Edward Belcher, R.N.

Plate LI, fig. 43 (*b*).—Iron Helmet of the above suit.

Plate LI, fig. 44.—A portion of the iron scales attached to the inner side of the above suit.

Plate LI, fig. 45.—The inner side of a Breast-piece of Jazerine Armour of iron scales, of the fifteenth or sixteenth century.—Colonel Fox's Collection. See also Grose's Treatise on Ancient Armour, pl. 30.—Critical Inquiry into Ancient Armour, Meyrick, vol. vii, pl. lvi.

Plate LI, fig. 46.—A Brigandine composed of large iron scales on the outside, probably of the same date as the above; left by the Venetians in the armoury of Candia on the surrender of that island to the Turks in 1715, and presented to the Museum of the Royal United Service Institution by Lieutenant-Colonel Patrick Campbell, R.A.

Plate LII, fig. 47.—Horn of the Rhinoceros.—Colonel Fox's Collection.

Plate LII, fig. 48.—Skull and Tusks of the Walrus.—Colonel Fox's Collection.

Plate LII, fig. 49.—Weapon of the Sword Fish; scale half inch to one foot.—Colonel Fox's Collection.

Plate LII, fig. 50.—Spear of the Narwhal; scale half inch to one foot.—Colonel Fox's Collection.

Plate LII, fig. 51.—Section, showing part of the timber of the ship "Fame," where it was pierced by the narwhal in the South Seas, through 2½ inch oak. The piece of the timber containing the portion of the tusk which had broken off in the ship's bottom was presented to the Museum Royal United Service Institution by Lieutenant A. T. Tulloch, R.A.

Plate LII, fig. 52.—An Esquimaux Spear, from Greenland, armed with the spear of the narwhal.—Museum of the Royal United Service Institution. The wooden handle is ornamented with two human figures, carved in relief; reduced to $\frac{1}{20}$th its natural size.

Plate LII, fig. 53.—Esquimaux Spear, constructed in the form of a fish, having a

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fore-shaft composed of the narwhal's tusk, inserted so as to represent the tusk of the animal; scale half-inch to one foot. Colonel Lane Fox's Collection.

Plate LII, fig. 54.—Esquimaux Lance, pointed with a walrus tooth.—Museum Royal United Service Institution; reduced $\frac{1}{20}$th.

Plate LII, fig. 55.—Esquimaux Tomahawk or Pickaxe, headed with the tooth of a walrus.—Museum Royal United Service Institution; reduced $\frac{1}{10}$th.

Plate LII, fig. 56.—Arrow Head, probably from South America, headed with the point of a deer's horn.—Christy Collection.

Plate LII, fig. 57.—War Club of the Iroquois, called "GA-NE-U-GA-O-DUS-HA," or "Deer-horn War Club."—League of the Iroquois, by Louis Morgan.

Plate LII, fig. 58.—North American Indian Club, with a point of iron.—Museum Royal United Service Institution; presented by T. Hoblyn, Esq.; reduced $\frac{1}{10}$th.

Plate LII, fig. 59.—Arrow, armed with the weapon of the ray, probably the "Trygon Histrix," from South America.—Museum Royal United Service Institution; reduced $\frac{1}{2}$.

Plate LII, fig. 60 (*a*).—Spine of the "Balistes Capriscus" erect.—Yarrell's British Fishes.

Plate LII, fig. 60 (*b*).—Horn of the "Cottus Diceraus." Pall.—From Cuvier's Plates.

Plate LII, fig. 60(*c*).—Horn of the "Naseus Fronticornis." Lac.—From Cuvier's Plates.

Plate LII, fig. 61.—Spear of the "Limulus," or "King Crab."

Plate LII, fig. 62.—Arrow, armed with the spine of the "Diodon."—Colonel Lane Fox's Collection; reduced $\frac{1}{4}$.

Plate LII, fig. 63.—Kanjar, or Indian Dagger, composed of the horn of the buffalo, having the natural form and point.—Colonel Lane Fox's Collection; reduced $\frac{1}{10}$th.

Plate LII, fig. 64.—Ditto, with metal blade, of the same form, having an ivory handle.—Colonel Lane Fox's Collection; reduced $\frac{1}{10}$th.

Plate LII, fig. 65.—Ditto, of the same form, having both blade and handle of iron. The handle is ornamented with the figure of a bird, and some small quadruped.—Colonel Lane Fox's Collection; reduced $\frac{1}{10}$th.

Plate LII, fig. 66.—Dagger formed of the horn of the sassin, or common antelope.—Colonel Lane Fox's Collection; reduced $\frac{1}{10}$th.

Plate LII, fig. 67.—Ditto, the points armed with metal.—Museum Royal United Service Institution; reduced $\frac{1}{10}$th.

Plate LII, fig. 68.—Ditto, of nearly the same form and use, composed entirely of metal, and having a shield for the hand.—Museum Royal United Service Institution; reduced $\frac{1}{12}$th. Similar shields are sometimes attached to those figured in figs. 66, 67.

Plate LII, fig. 69.—Weapon composed of the horn of the antelope; steel pointed; supposed to be that used by the Fakirs in India.—Colonel Lane Fox's Collection.

Plate LIII, fig. 70.—Sword formed of the serrated blade of the saw-fish from New Guinea.—Museum of the Royal United Service Institution.

Plate LIII, figs. 71, 72, 73, 74.—Weapons from the Pacific Ocean, edged with the teeth of the shark. The teeth near the points are placed points forward; the remainder with the points towards the handle. Two methods of fastening the teeth are shown; in grooves, and lashed between two strips of wood.—Museum of the Royal United Service Institution.

Plate LIII, fig. 75.—Implement from New Zealand, armed with sharks' teeth.—British Museum.

Plate LIII, fig. 76.—Esquimaux Knife, armed with pieces of meteoric iron, from Davis Strait.—British Museum.

Plate LIII, fig. 77.—Knife, armed with pieces of iron along the edge, from Greenland.—Christy Collection.

Plate LIII, figs. 78, 79, 80.—The Mexican Maquahuilt.—From Lord Kingsborough's work on Mexican Antiquities.

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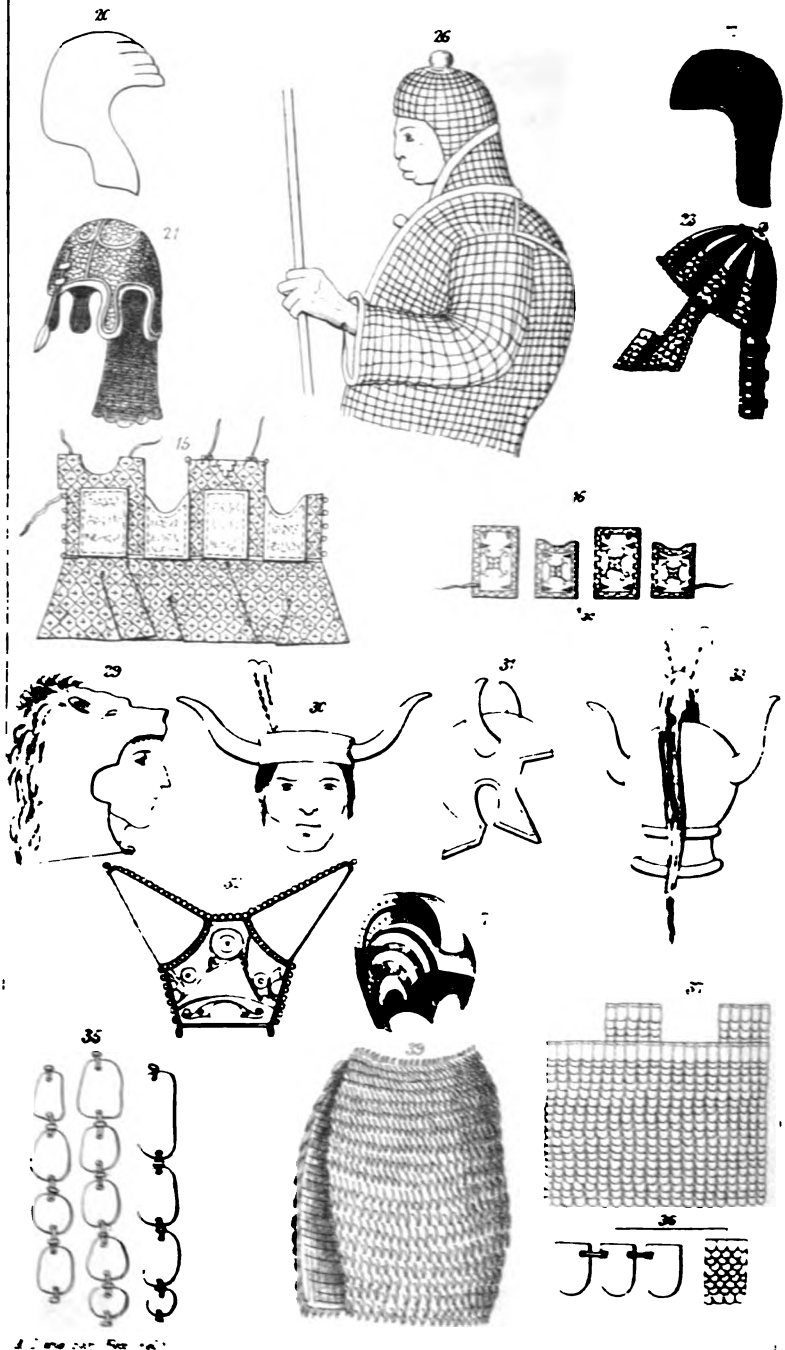

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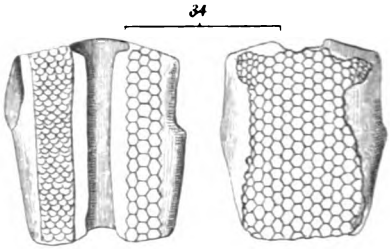

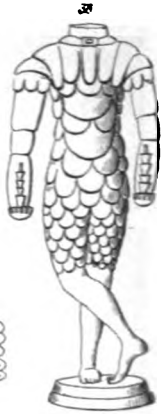

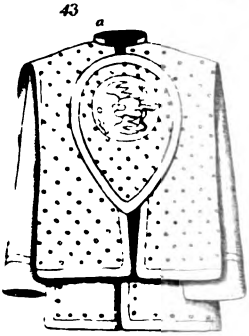

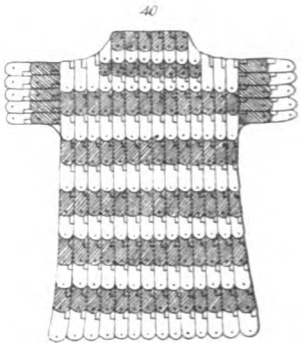

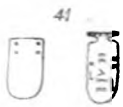

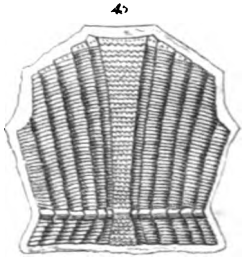

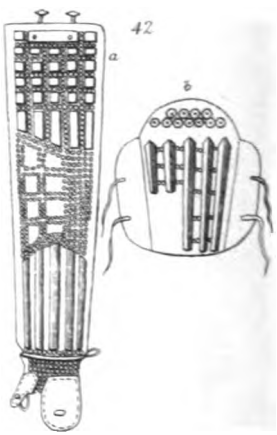

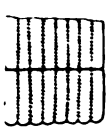

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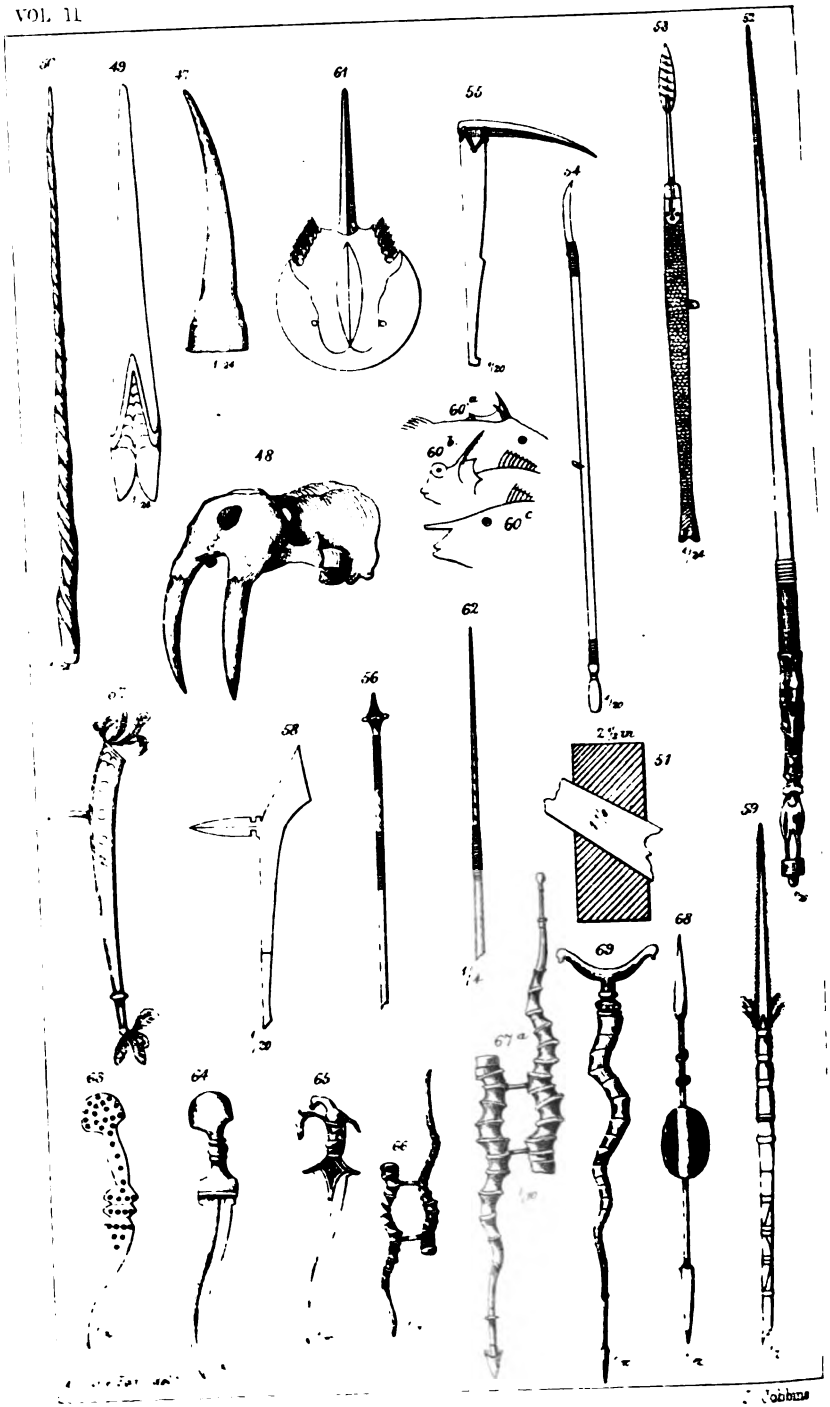

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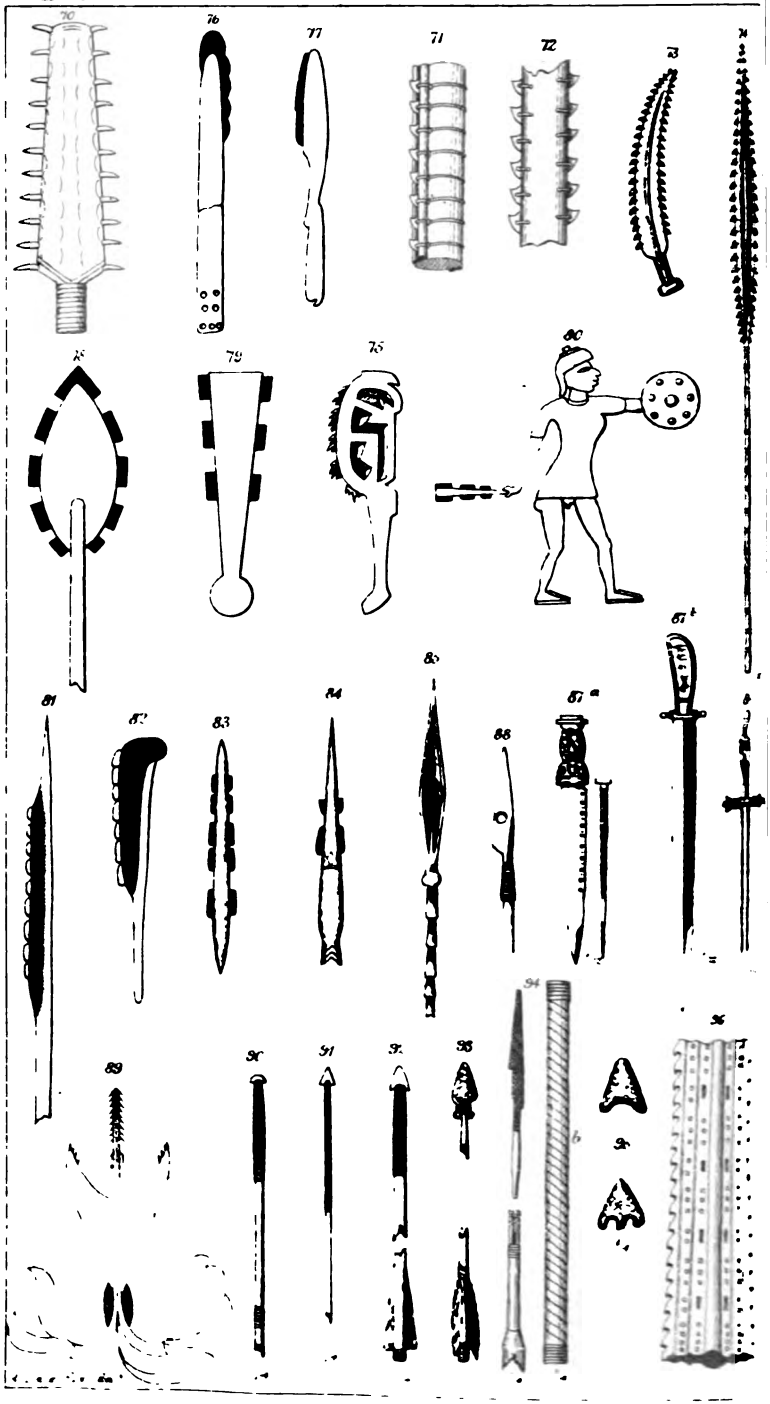

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Plate LIII, figs. 81, 82.—Spear and Knife, from Australia, armed with pieces of obsidian, or rock crystal.—Museum of the Royal United Service Institution.

Plate LIII, fig. 83.—Bone Arrow-point, armed with a row of sharp flint flakes on each side.—Museum of Professor Nilsson, at Lund, in Sweden. Reduced to one-half, from the figure in Wilde's Illustrated Catalogue of the Royal Irish Academy, Animal Materials, p. 254.

Plate LIII, fig. 84.—A similar implement to the above, in the Copenhagen Museum. —From the Illustrated Catalogue of the Copenhagen Museum.

Plate LIII, fig. 85.—Hollow Bone Arrow-point, from South America, the hollow of the bone being filled with poison.—Museum of the Royal United Service Institution.—Colonel Lane Fox's collection.

Plate LIII, fig. 86.—An Italian Bravo's Dagger, with grooves and holes to contain the poison. The handle represents a monk in the act of supplication.—Colonel Lane Fox's Collection.

Plate LIII, fig. 87 (*a*).—A Scotch Dirk, pierced with holes along the back and sides. A groove runs along the back of the blade eight inches in length, in which holes are pierced that communicate with lateral holes on the side of the blade.—Captain A. Tupper's Collection.

Plate LIII, fig. 87 (*b*).—A Couteau-de-Chasse, having two grooves on each side near the back of the blade, which is pierced through with holes.—Colonel Lane Fox's Collection.

Plate LIII, fig. 88.—Arrow Head, of iron, with a hole near the point for poison, from South America.—Colonel Lane Fox's Collection.

Plate LIII, fig. 89.—The Serrated or Multi-barbed Sting of the Bee.—Huber on Bees.

Plate LIII, fig. 90.—Point of the Bushman's Arrow, barbed with an iron head. The head is constructed to come off in the wound.—Colonel Lane Fox's Collection; reduced ½.

Plate LIII, fig. 91.—Iron-headed Arrow of the Maay Blow-pipe; similarly constructed.—Colonel Lane Fox's Collection; reduced ½.

Plate LIII, fig. 92.—Similarly constructed Arrow of the wild tribes of Assam, headed with copper; reduced ½.—Colonel Lane Fox's Collection.

Plate LIII, fig. 93.—Flint Arrow Head of the Shoshones of North America; constructed to come off in the wound.—Schoolcraft, vol. i, p. 212-13.

Plate LIII, fig. 94.—Arrow Point of the Macoushie Indians of South America; constructed so as to detach in the wound; reduced ½.—Colonel Lane Fox's Collection; presented by the Rev. J. G. Wood, M.A., F.L.S.

Plate LIII, fig. 95.—Flint Arrow Heads, from the north of Ireland.—Colonel Lane Fox's Collection; reduced ½.

Plate LIII, fig. 96.—Part of the serrated and pierced Blade of an Italian Dagger; full size.—Engraved illustration of Ancient Armour, Meyrick, Skelton, vol. ii, pl. cxiii.

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Evening Meeting.

Monday, June 24th, 1867.

VICE-ADMIRAL SIR H. J. CODRINGTON, K.C.B., in the Chair.

NAMES of MEMBERS who joined the Institution between the 17th and 24th June, 1867.

ANNUAL.

Vaughan, Hon. E. C., Lieut. Rifle Brigade. 1*l.*
Eyre, Henry R., Capt. Coldstream Guards. 1*l.*

A NEW MODE OF MARINE PROPULSION.

By Captain C. H. SIMPSON, R.N.

IT is with considerable diffidence that I have undertaken to read a paper upon so important and difficult a subject as "marine propulsion," especially as I am aware that amongst my hearers are men eminent alike for their scientific acquirements and practical experience; but as persons who have no such claims to consideration, have sometimes hit upon valuable ideas, I propose to bring to your notice this evening a plan, the result of not simply a happy idea, but of constant thought and frequent experiment during the last ten years. The experiments have, unfortunately, been on too small a scale to be considered decisive, but sufficient, I think, to intimate with tolerable certainty the result to be anticipated.

It may be as well for me to mention here the results I considered necessary of attainment, in a good propeller.

1stly, and most important, speed.

2ndly. Not to interfere with the gun-decks; and freedom from fouling by rigging, &c. shot away in action, with perfect security from injury by enemies' shot, &c.

3rdly. Manœuvring powers.

4thly. Non-interference with the sailing qualities of the vessel.

5thly. Economy of space.

6thly. Reduction of expense.

How near I have approached to the attainment of any of these objects, I will presently ask you to consider; but, before doing so, I will state shortly the steps by which I have arrived at my present plan.

I started with the conviction, that my object was to be attained only

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by means of an internal propeller, that is to say, by some method of taking the water into the ship, and driving it out again.

It would be both tedious and unnecessary to explain the various modifications of plunges and squirts I devised and experimented upon; it will be sufficient for me to say, that it gradually dawned upon me that no plan could possibly be successful that did not drive the water through the vessel in a continuous stream without check. This being the case, it may occur to many, that my ideas were realised in the hydraulic propeller as patented by Mr. Ruthven. This, however, was not so; I had studied Mr. Ruthven's plan with great attention, and for reasons, which I purpose to explain presently, I rejected it.

I therefore followed out my own ideas, which I embodied about four years ago in the model before you, and which you will perceive embraces the idea of a straight internal passage for the water leading directly through the vessel, Plate liv, fig. 4*a*; both ends of the vessel are alike, with a balanced rudder at each end working across the water-passage so as to feel the whole benefit of the stream, and alter its direction at pleasure. For instance, if both tillers are put over to starboard, the bow-rudder will divert the stream entering from right ahead, and oblige the propeller to draw it in on the port bow, whilst the after-rudder will receive the whole force of the stream as it issues from the passage, and divert it to the port quarter, and thus by a combined rudder and water action, if I may use the expression, acting at the extreme ends, pivot the vessel on her centre.

My method of propulsion is as follows, and consists of a hollow cylinder or drum (Fig. 1), closely fitted in a casing, but with sufficient room to revolve freely therein; it is mounted on an axis, by which it is driven in the manner of a paddle-wheel. The hollow drum is furnished with a number of slits or casings, disposed radially, and open at the circumference. In these casings which each extend the length of the cylinder, are fitted pallet-, or float-boards, by which the propulsion is effected. These floats slide in a radial direction, and are capable of projection beyond the periphery of the cylinder to an extent to offer the requisite amount of surface to the water for propulsion.

The position of the floats is controlled and regulated by pins or studs (with or without truck-rollers or wheels), projected from each end of the floats. The pins or studs travel in cam-grooves in the outer casing, so arranged as to project or withdraw the floats during the proper periods in the revolution of the drum or wheel. The case enclosing the drum or wheel has an arc or section removed at the part where the floats are projected from the drum; this opening in the case may either be united with a channel passing through the body of the ship, or it may be united with the sides or bottom of the ship; so that the floats, when so projected, pass into and operate on the external water.

This wheel being hollow, and wholly, or almost wholly below the water-level, will, by its buoyancy, relieve the bearings of weight and friction.

When, in order not to interfere with the sailing qualities of th

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vessel, it is desirable to withdraw the whole of the floats within the periphery of the wheel, it is simply necessary, by means of points, similar to those used on a railway, to alter the course of the cam-grooves in the outer casing. This casing is, of course, water-tight, and is fitted with a semi-circular slide, which, when the floats are turned off within the barrel, is closed, thus shutting off all communication with the outer water, and enabling repairs, &c., to be carried on in any weather.

It may be observed, that my invention of the sliding float, worked by a stationary cam-groove, could be applied so as to drive the water in any direction in a continuous stream through the vessel without check, and was also applicable for external propulsion.

It became an interesting question to ascertain which of the two modes of application would be preferable.

I therefore fitted a small boat, about 7 feet long and 18 inches beam, with my propeller, with the floats projecting through the bottom of the boat and acting on the external water (the motive power used to drive the propeller being a powerful piece of clockwork). The boat was placed in the water with her stem against the bank, and the clockwork being wound up, it was started, and the time that was taken to unwind five turns of the spring accurately noted; this was invariably 70 seconds. After this was done repeatedly, and not a second's variation in the time observed, the boat was taken out of the water and a false bottom, of about 18 inches in length, fitted over the floats, thus making a clear, straight passage, open fore and aft, of a size exactly corresponding to the full projection of the float. The boat was then placed in the water as before, and the clockwork started, when the five turns of the spring were invariably unwound in 55 seconds, thus practically showing the greatly superior resistance offered to the action of the floats by the external water, to that offered by water in a tube or passage.

Now, I am aware that I am venturing on dangerous ground when I attempt to state the cause of this difference; we are pretty safe as long as we keep to facts, but may very soon get bowled over if we venture to account for them. As however, I believe that the object of this Institution is not simply to record a number of facts, however interesting, but to promote discussion, I shall not hesitate to state my own ideas on this and other points connected with my subject, feeling assured that my doing so will not be considered presumptuous.

I believe, then, that the cause of this great difference in the resistance offered, to be due to the fact that in the tube or passage, an area of float-board equal to only one whole float meets with any resistance at one time, but that this resistance will be equal to the true theoretical resistance due to the reaction of water discharged at a given velocity. Whilst in the case of the propeller acting on the external water, the whole area of float-board equal to two floats, that in my case are always extended, bore a portion of the resistance felt, and that as the velocity of the vessel, through the water, is increased, so will the resistance on the whole of this area approximate more nearly to this theoretical resistance; and though, practically, this float-surface may

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never quite meet with double the resistance of the internal propeller, I can imagine its doing so very nearly, and hence I argue, that the size of the propellers and their floats being equal, the propeller acting on the external water must give a far higher speed with a given power, than the propeller acting in the through passage.

I should now like to say a few words on the hydraulic mode of propulsion, on account of the intimate connection it has with the ideas and experiments I have been endeavouring to describe to you. It is, in fact, an internal propeller of somewhat different form from mine, but dependent for its propelling power upon similar principles, viz., the reaction due to the water discharged at a given velocity. For instance, supposing I were to block up my water passage before and abaft the propeller, and introduce tubes so as to carry the water out and bring it in through the sides of the vessel, Fig. 4*b*; I have only to fit the nozzles or discharge-pipes on the ends of the upper tubes, and I have the hydraulic propeller, not the turbine-wheel, but the hydraulic propeller.

In considering, then, the two plans, the question arises which is the most convenient form of application—to use the straight passage, and thus to communicate the pressure due to the reaction of the water, directly through the float to the vessel, or by making the water take an indirect course, cause the pressure due to its reaction to be felt at the back of the discharge-pipes.

Now, if we put the question of friction on one side, and suppose two similar vessels of the same engine power, fitted with propellers one on each of these plans, we should find, as long as the vessels were stationary, that each would drive out, or discharge the same weight or quantity of water; but when we come to compare the action of the two plans with the vessels in motion, we shall see a great difference. For instance, suppose the vessel with the straight through-passage to be moving at the rate of 9 knots, or 15 feet per second, through the water, as there is no friction, the water will flow through the passage of its own accord at that rate, and the floats of the propeller would have to travel at that velocity + the velocity necessary to accumulate upon them a pressure or resistance equal to the moment of resistance of the ship (as is the case with the ordinary paddle-wheel). If we suppose this to be 7½ feet per second, the power used will be that of a weight equal to the moment of resistance of the ship, moved with a velocity of 22½ feet per second.

With the hydraulic propeller however this is very different. The water discharged, and its consequent reaction at the back of the discharge-pipes, will be the same, whether the vessel be at rest or moving through the water, consequently if her discharge pipes are equal in area to the float surface, and no other retarding force peculiar to the plan be brought into play, the power required to propel her 15 feet per second would be only that of a weight equal to the moment of resistance of the ship for that speed, moved with the velocity of 7½ feet per second, or one-third of the power required in the other vessel.

But there is, I believe, a most important retarding force brought into play, and I believe it to be this. The water that is taken into

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the vessel when she is in motion is taken from a state of rest, and is not only driven through the tubes and passages by the engine, but is also carried forward by the ship, and consequently the momentum of the ship is destroyed by a force equal to that required to move the quantity of water taken in in a given time, a velocity equal to that of the ship's motion, and consequently that water must be discharged in the opposite direction with a similar velocity before its reaction at the back of the discharge-pipes will counterbalance this loss, and the excess of the velocity at which the water is driven through the discharge-pipes, over that of the ship, is alone available for propulsion, or, in other words, for overcoming the moment of resistance of the ship. It is evident, therefore, according to its principle, that in order to get an available pressure at the back of the discharge-pipes equal to the moment of resistance of the ship, the engine must be sufficiently powerful to drive the water through the discharge-pipes with the velocity of the ship + the velocity necessary to accumulate that additional resistance.

I will try and illustrate this principle from the information I have been able to obtain about the "Waterwitch." That information, I am sorry to say, is very meagre, and is, in fact, chiefly limited to what I was enabled to gather from Admiral Elliot's lecture the other night: it is this, that the speed of the "Waterwitch" was roughly nine knots, the velocity of the discharge of water was double the speed of ship, or 30 feet per second, and I have also ascertained that the area of each discharge-pipe is 480 square inches, or both together 960 square inches. The reaction, therefore, due to that area and velocity of discharge is roughly 12,000 lbs., which equals the gross moment of resistance of the ship; but according to my theory, the net or true moment of resistance, that offered to the ship's passage by the external water, will be this pressure—the pressure due to the reaction of discharge at 15 feet per second (the velocity of ship) = to 3,000 lbs.; consequently 9,000 lbs. is the net moment of resistance, and the 3,000 lbs. represents the retarding force. The net indicated horse-power required to propel the ship 9 knots, or 15 feet per second, will, therefore, be about 655. Any horse-power above this that may have been used, is absorbed in friction. I believe the total indicated horse-power used, to have been about 830.

The question is, is this a satisfactory result? I see in the account of the "Rattler's" experiments (a vessel of 888 tons), that with a horse-power calculated from dynamometer of 219 she obtained a speed of 9½ knots. The net indicated horse-power, which includes the loss due to the angle of incidence of the screw-blades, was 309, and the gross horse-power, which includes friction also, was 428. The moment of resistance of ship calculated from dynamometer was 7,530 lbs. Now, evidently, according to my calculation, the lines of the "Waterwitch" are very inferior to those of the "Rattler," but the difference in power used for the same speed is as two to one; and if my idea of this mode of propulsion (the hydraulic) is correct, the lines will make less difference in the speed of a vessel propelled by it, than with any other mode of propulsion.

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But it becomes an interesting question to ascertain what would be the effect of increasing the size of the discharge-pipes. I believe that if the discharge-pipes in the "Waterwitch" were increased to four times their present area, or 3,840 square inches, the result would be nearly as follows:—Pressure at the back of discharge-pipe due to a velocity of discharge equal to speed of ship, or 15 feet per second, 12,000 lbs.; net moment of resistance of ship, 9,000 lbs.; gross moment of resistance, 21,000 lbs.; total velocity of discharge of water to obtain that resistance or pressure, 20 feet per second; net indicated horse-power, 760. It would appear then from this, that the smaller the discharge-pipes, the better; but as the friction, of course, increases with the contraction of the pipes and the velocity of discharge, there will be a limit to this, and I have no doubt that that limit has been reached in the "Waterwitch."

There are, however, other peculiarities of this mode of propulsion, now well established and justly admired, which tend to prove the theory I have laid before you. I allude to the remarkable power displayed by vessels propelled on this principle, of starting ahead, and stopping. At first sight the combination of this power with an inferior propeller appears incompatible, but a little consideration will show that both are due to the same cause, viz., the necessity entailed on the vessel of giving a velocity equal to her own to the water used for propulsion.

For instance, for a speed of 15 feet per second for the "Waterwitch," it is necessary to discharge the water at the velocity of 30 feet per second, and we have a pressure at the back of the discharge-pipes available for propulsion equal to 9,000 lbs., but if, while the vessel is moving ahead at this speed, the orifice of the discharge-pipes were suddenly changed so as to discharge the water directly forward, evidently the whole of the pressure at the back of the discharge-pipes that, due to a velocity of 30 feet per second for the water, or 12,000 lbs., is brought to bear to stop her; and not only that, but all the water she is taking in is acting in the same direction, and only ceases when the vessel is brought to rest; in other words, a pressure equal to 15,000 lbs. is suddenly brought to bear to stop her; one portion of this force, equal to 3,000, is gradually reduced until the vessel is brought to rest, when it ceases, but is gradually brought into play again, as an opposing force, as the vessel gains her speed in the opposite direction to that in which she was before moving. In starting from rest, the vessel is impelled by an effective pressure proportionate to the whole velocity of discharge, which effective pressure is gradually reduced as weigh is got on the vessel; and in turning with the discharge-pipes, the whole of the force due to the reaction of discharge is brought effectively to bear. These are advantages peculiar to the plan; and when the ease with which the direction of the discharge can be changed without reference to the engine, is considered, cannot fail to have great weight with those who have to decide upon its adoption into the Service. But these advantages, great as they are, are not obtained without a sacrifice. A vessel, fitted as the "Waterwitch," must have inferior rudder-power to a vessel that throws a stream of water upon the rudder,

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and therefore could not manœuvre so quickly in a running fight, or where it was required to turn rapidly without loss of speed.

There is one point more. I have seen it stated, that as it is ascertained that there is no advantage in having the discharge pipes of the hydraulic propeller immersed, therefore the motion of the vessel in a seaway will not interfere with her propelling powers; but though the immersion of the discharge-pipes may produce no beneficial effect, it does not follow that raising them a considerable height out of the water will not cause waste of power: it will, in fact, I think, cause great waste of power; for instance, suppose the discharge pipes to be fitted, as in the "Waterwitch," just above the water-line, and that the vessel is rolling 20° each way, this in the "Waterwitch" would raise each discharge-pipe alternately about 6 feet above the water-line, giving an average height of 3 feet that the whole of the water discharged, "nearly 400 tons a minute" would have to be raised by the engine without any compensating advantage, and is consequently a clear waste of power.

I have now arrived at this point, that for the various reasons I have endeavoured to make clear to you, I conclude, that for an internal propeller, the direct passage is greatly preferable in point of speed, but that the hydraulic principle, in proportion to its sacrifice in this respect, obtains a distinct, and in some cases valuable manœuvring power, but I have before stated that I have also arrived at the conclusion, that all internal propellers, of equal size with external ones, must fail in the primary object of speed; and that therefore the best propeller will be the one that combines within itself, in the greatest perfection, the good qualities of both the internal and external systems, and this is the principle upon which my propeller is constructed. It has the advantages of the internal propeller, in its freedom from fouling, by spars or rigging shot away in action, and from injury by an enemy's shot, &c. It gives superior manœuvring power to any other mode of propulsion, for it equals the screw in rudder-power, as the floats throw the water directly upon the rudder; it pivots the vessel on her centre, if two wheels are used and made to revolve in opposite directions; and is capable of propelling the vessel, either end first, with equal speed and facility. It is superior to the screw, as a submerged propeller, it being impossible under any circumstances for the motion of the ship, whether by pitching or rolling, to interfere in the least with its direct and steady action. It is equal to the eccentric paddle-wheel, in the directness of the action of the floats, but greatly superior to either radical or eccentric paddle in its steady and invariable immersion, and freedom from vibration, the floats never striking, or lifting the water, but sliding gradually, though rapidly, in and out of it Lastly, it is superior to either screw or paddle in the comparatively undisturbed, and unyielding water, that it is enabled by its position and superior immersion, to act upon.

In the competitive trials between the ordinary radial paddle-wheel and my propeller, applied to the same boat, and driven by the same engine, the immersed float area being equal in both cases, and the speed of the vessel also being equal, the power used by the ordinary paddle-

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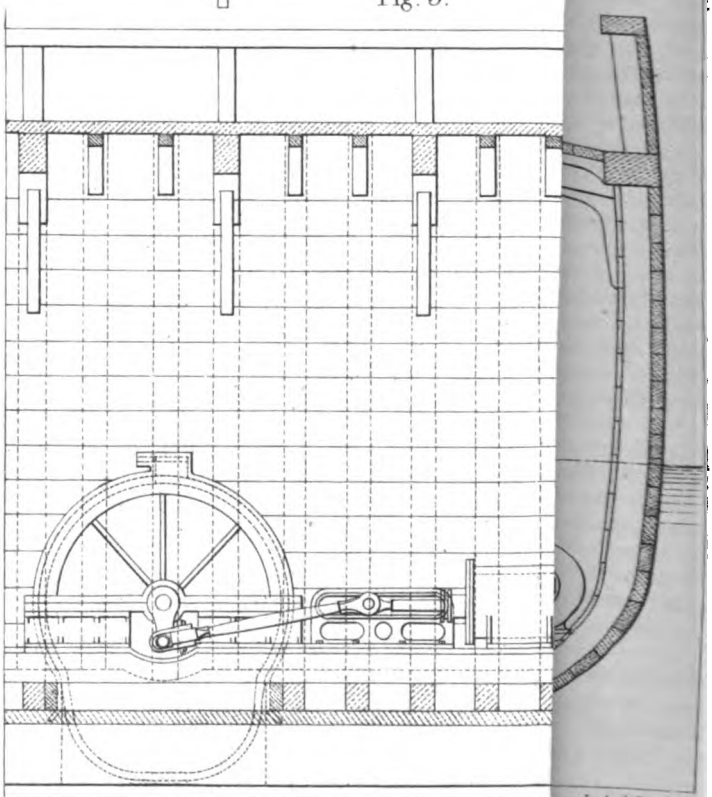
a Propeller

Fig. 4

b

Fig. 3.



J. Jobbins.

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wheel was as 7 to 5 used by my propeller, the slip of the paddle-wheels being about 40 per cent., of my propeller about 17 per cent.

In turning with the common rudder, the paddles made the circle in 40″, my propeller in 30″.

Now of course these trials, though they were fairly made, cannot be considered decisive; they give, however, I think, a fair indication of the results to be anticipated, and indicate, I think, a certainty of obtaining, especially in a seaway, a very superior speed.

I have now touched upon the three most important points in estimating the value of a propeller, viz., speed, clear gun-decks, and freedom from fouling, and manœuvring powers.

In considering my plan with regard to the sailing qualities of vessels, I think that there can be little doubt but that the rounded inequalities in the bottom of the vessel fitted with my propellers will offer less resistance to the passage of the vessel through the water than the double stern-post of the single screw, or the drag of the disconnected twin screws; and I believe as little, if not less resistance than the friction of the numerous holes in the bottom of the hydraulic vessel, and the drag of the lee discharge pipes; I also believe that the double or treble keel (Figs. 2 and 3), which my plan necessitates, will add greatly to the vessel's stability.

With regard to space occupied, I am afraid that my plan, as here presented to you, will not bear quite so favourable a comparison, though I doubt if even here there will be much to complain of; I have the space occupied by the barrels and their cases, as compared with the space occupied with the screw alleys, in the screw vessel, and the space occupied by the turbine, and the different tubes, and water-passages, in the hydraulic vessel. In order to make an approximate comparison, I will give a rough estimate of the size of my barrels, supposing two barrels to be used. The length of each float, and consequently of each barrel, is one-third the beam of vessel, and the diameter of barrel, six times the required extended breadth of float; consequently, supposing that in a vessel of "Waterwitch" class, it was desirable to have 20 square feet of surface in each float, the barrels would be 10 feet long, and 12 feet in diameter, which would give my plan no very decided inferiority in this respect.

We now come to the last point, viz., that of expense, but notwithstanding its importance, I am afraid I can give no more than a very rough estimate of the relative expense of the different plans.

There can be no doubt but that the first cost of the screw, in itself, is by far the least, but the screw necessitates the expensive overhanging stern, in order to protect it; whereas both the hydraulic vessel and mine would have both ends alike. There will probably be no great difference between the first cost of my propeller, as explained to you to-night, and the hydraulic propeller; but the first cost of a propeller must be a comparatively small item in its value. The propeller that gives the highest speed, with the smallest consumption of fuel, must be the cheapest, and this, in anticipation I claim for mine.

The CHAIRMAN: Captain Simpson, as no doubt some questions will be asked you presently for information, perhaps you will be kind enough to take a note of them,

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so as to answer them at the end. There are one or two points upon which I should like more information. The first is with regard to the friction of those studs that I see in the model. If they rise and fall, as I understand they do, I want to know whether the friction would not be excessive in them. In the next place I think you made mention that the drum would be water-tight. I do not trace any provision by which, if the studs are to rise and fall, the drum could be water-tight. Next, with regard to that casing that you put on below to shut the box up. I do not well see how that would be water-tight.

Admiral ELLIOT: I should like to ask a few questions. In the first place I have great delicacy in putting questions, for fear I should appear to be attempting to condemn a new motive power, which has never been tried except on a very small scale. Having decried that mode of action myself, I should be very sorry to set the example this night, but there are one or two questions I should like to ask Captain Simpson, which I am sure he will excuse, and not suppose I am trying to run his principle down. There was one point particularly which Captain Simpson mentioned the other evening with regard to the loss of power of the hydraulic. It has been proved by facts that there is no such loss of power, but I am not surprised at what Captain Simpson says, because even Mr. Brunel years ago, announced that by scientific analysis the hydraulic propeller must lose 50 per cent. of its power; and others went a great deal further than that. The question I would ask is this, supposing a vessel to be going twenty knots an hour, and supposing you fire your stern gun, as a stern chaser, will the recoil of that gun be retarded?* That is to say, will the reaction upon the rear of that gun be less in consequence of the speed at which the ship is going? Will not the recoil of that gun be exactly the same as if the ship was stationary? I ask this question, because the whole power that is obtained with the hydraulic, as in the "Waterwitch," is entirely the same as the recoil of a gun. I maintain that there is no loss of power whatever. If a ship is going fifty miles an hour, and you discharge the gun, a stern chaser, I ask Captain Simpson whether the gun will recoil more or less in consequence of the speed of the ship? If he says "No," then, I say, that the reaction which takes place on the nozzle by the discharge of the water, is exactly the same thing, and consequently no loss of power follows. That is one question I would put. Another question I would ask is, whether in the experiments that have been made on this very small scale with a screw, in a very light boat, the screw having been used in the same vessel as this new motive power, whether it was not at a disadvantage to what it would have been had it been used in a perfect vessel? I am alluding to the fact of the very large loss of displacement which takes place in that vessel, which must be given to the vessel in some other form, and consequently must produce in a larger vessel to drive—a greater direct resistance. I know that in the "Waterwitch" the loss of displacement due to the turbine and the canal is an objection. She has to get that displacement in her form in some other way, and she has to carry that body of water with her as she goes—so many tons of water due to the displacement which that space affords; which is, in fact, her carrying a heavier cargo. Here I notice that the loss of displacement is very considerable—that canal the whole length of the vessel, and those two large spaces there—that it is a very great loss. Added to which I would ask Captain Simpson, whether in the form of the vessel necessary to enable him to have this opening, he will not also find a very great loss by the abruptness of his horizontal lines? I would also ask whether he has ever thought, if a ship is rolling,

* The whole of the reaction or recoil due to the discharge of a gun over the stern, is felt by the ship, whatever her speed may be, because the charge which gives that recoil has, before it is fired, a velocity equal to that of the ship; but a power necessary to move that charge at that velocity has been used, and in order to make the cases of the discharge of the gun and the discharge of the water by the hydraulic vessel parallel, it would be necessary that the whole of the water to be discharged by the hydraulic vessel should be stored up within her, failing this the cases are not parallel, and the argument in no way touches my theory of the action of the hydraulic propeller as stated in my paper.—C. H. S. (4th October, 1867).

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and that canal is filled with water, whether in that case the water will be passing through of its own accord, or whether the rolling of the ship will not throw the water upon each side of that canal, and create some retarding influence upon the speed of the ship, or be a loss of power to his engine? Captain Simpson also talked of raising the nozzles a considerable height above water. I would ask Captain Simpson whether he has ever heard it mentioned by any one who advocates the hydraulic principle, that the nozzle should be lifted more than just its own height above the water-line. Added to the loss of displacement which occurs, I would ask whether a vessel upon that principle must not necessarily be a heavier vessel in her hull, consequently creating a greater amount of displacement necessary to a greater resisting power of vessel. I would also ask, as Captain Simpson has referred to the speed of the "Waterwitch," whether, providing he is informed that a series of trials at different speeds of engine have been made from twenty revolutions up to forty revolutions, and it was found that, as the speed of the ship increased, it in no way disturbed the law, which law is, that the power is as the cubes of the speed, whether it would not shake his opinion, that as you increase the speed of the vessel, you increase the loss of power. I must now ask him to excuse me for putting so many questions.

Captain SIMPSON: Would you put that last question again?

Admiral ELLIOT: Provided you were satisfied that a series of experiments were made to test the very point upon which you have been expressing a strong opinion, namely, that as the speed of a ship increases, you get increased loss of power; whether, if you are satisfied that a series of experiments having been made at different speeds of ship, from twenty revolutions of the engine up to forty, it was found that the law—(that the power is as the cubes of the speed)—became strictly correct in every instance, whether that would shake your opinion with regard to the loss incurred by the speed of the vessel? I would, by way of explaining that more fully, ask this question. Supposing the speed at which the water was discharged from the nozzles was equal only to the speed of the vessel, whether Captain Simpson, according to his theory, maintains that the whole power would be lost. He said that the power that was obtained was only due to the speed that the water was discharged at, beyond what the speed of the vessel was. But if I discharge water through a larger pipe, and discharge it exactly at the same speed as the vessel, namely, 10 knots, and that I get the same results as by using a smaller pipe and discharging the water at double the speed of the vessel, then where is Captain Simpson's theory? Because there is a vessel at this moment building at Liverpool for a tug, in which the discharge of the water is at a very much lower speed than in the "Waterwitch." It is done for a special purpoce. She is to be a tug-boat, and it was thought that the heavier momentum of water, would be more advantageous. But I maintain that if you discharge the water through the pipe at the same speed that the ship is going, by having larger pipes and the same power, you will obtain the same speed as by discharging it at double the rate she is going, with half the quantity of water.

The CHAIRMAN: If no other gentleman would like to make any remarks, I will call upon Captain Simpson to reply.

Captain SIMPSON: I think the first question was with regard to the barrel being water-tight. The compartments are water-tight, but in this instance the cases in which the floats work are not water-tight, are not supposed to be water-tight. If it is an advantage that they should be water-tight they could easily be made so. There is no great quantity of water that will get in there. Simply a sufficient quantity of water will get in to ease the friction. There is always a slight friction in drawing the floats out, but it must be remembered that there are only two floats at the same time moving, and I believe the friction will be less than in the feathering paddle-wheel, where all the floats are always moving. With regard to the three or four questions put by Admiral Elliot—

The CHAIRMAN: I beg your pardon, I also asked about the tightness of the compartment below.

Captain SIMPSON: This top I simply took off the model in order to show the working; but I conclude it would be closed except in a small space, enough to lift the float when required to be examined, and then it would be all water-tight. This outer casing would be built in the bottom of the vessel, and built in one, not slipped

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in, as it is here. In an iron vessel it would be built into the vessel; if in a wooden vessel, it would be caulked. With regard to the three or four remarks that Admiral Elliot made, with regard to this vessel, this, as I said in my paper, was not a plan that I recommended, it was one that I tried. I gave up the internal passage as I believed it to be inferior to the float acting on the external principle.

Admiral ELLIOT: I beg your pardon, I thought you said the contrary.

Captain SIMPSON: I simply brought it to show you I had followed out my ideas in this. The internal passage might be used with a larger propeller; and, no doubt according to the size of that passage, the displacement would be in proportion to the weight of water carried. There is no question about that. I believe the floats acting externally would not only give a higher speed, but would also occupy less space. The next question was with regard to the discharge of a gun. I think I stated before, that the whole of the reaction of the water discharged did re-act upon the back of the nozzle. It did not signify how slow it was going, or how fast, the whole reaction due to the velocity of the discharge is, undoubtedly, felt at the back of the nozzle; but what I said was, that when the vessel is moving ahead the water will not enter of its own accord, but the engine has to draw it in; and as she passes on, she is continually drawing fresh water in. She has not simply the body of water there and it remains there, but she is continually drawing fresh water in, and taking it from a state of rest as she is moving; consequently every particle of water she takes in, she has to give a velocity to, equal to her own. It is drawn in at right angles, and she cannot draw any particle of that water in, without giving it a velocity equal to her own velocity. It has nothing to do with what the engine does at all. The ship itself does it, and the ship's momentum is destroyed in proportion to that; consequently the discharge must be increased to overcome that destruction of momentum.

Admiral ELLIOT: I am sure it will not be objected to that we should just settle this point. There are two distinct considerations involved in Captain Simpson's last remarks. One the entrance of the water, and the other the imparting to that water the velocity of the ship. Now as to the supply of water to the turbine. I maintain that as that supply is due entirely to the atmospheric pressure, or, as the water will always rise to its own level, the entrance of the water into the turbine is entirely done for you; and that there is no power of engine exerted to produce that effect. The moment you move the engine the turbine moves, if a bucket of water is taken out, that bucket of water is immediately replaced by the atmospheric pressure acting upon the water outside, and there is no loss of power due to the entrance of the water into the turbine. As to the second consideration, I acknowledge that apparently the momentum of the vessel has to be imparted to the water taken up, and that this would create a retarding influence to its speed, but as the entrance of the water into the canal is before the turbine, and as it is carried through the turbine at a speed greater than the speed of the vessel, its flow, although diverted from a straight line, is not arrested, and it does not appear that there is any loss of power sustained by this lifting up of the water, when at rest, and forcing it out again.

Captain SIMPSON: If the engine had not to do any work in driving the water through, the vessel might be propelled without any engine power. At any rate that is my idea of it, that the vessel takes in the water. If she takes it in at the end, as in my model (Fig. 4 *a*), the water flows through of its own accord. If she takes it in at the side (Fig. 4 *b*), the water will not flow through of its own accord; she has to take it in as she is moving rapidly forward; consequently, the water must have the velocity given to it that the vessel has, and the vessel's momentum must be destroyed, in giving to that water, that velocity. I quite believe with Admiral Elliot, that the power that is due is as the cubes of the speed, certainly with the turbine. "This unbalanced pressure," according to Dr. Robinson, "is equal to the weight "of a column having the orifice for its base, and twice the depth under the "surface of the water in the trunks for its height. This measure of the height "may seem odd, because, if the orifice were shut, the pressure on it is the weight "of a column reaching from the surface. But when it is open, the water issues "with nearly the velocity acquired by falling from the surface, and the quantity "of motion produced is that of a column of twice this length, moving with this

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"velocity." That I believe to be the result in this; that the reaction of the discharge is simply due to that. If a vessel goes at ten feet a second, you discharge your water at twenty feet, and if you double your speed, you double your discharge. With regard to the fact, that the ship may be propelled at the same speed at which the water is discharged, if that is not proved, it is a thing which I should deny. I believe, as soon as it arrives at the same velocity—in fact, it never can arrive at the same velocity—the vessel's speed will be immediately slackened, because the moment of resistance of the ship will be greater than the power.

Admiral ELLIOT: I believe it is contrary to the rule to rise again else I could explain that at once.

The CHAIRMAN: You may do so.

Admiral ELLIOT: For the sake of argument I will just explain again. If you acknowledge that the power that is obtained is entirely by reaction, if I discharge a column of water of double the size at half the speed, I get a reaction upon a larger area, and therefore I get the same power. It is a column of water discharged at one speed, *versus* another column of water at another speed, the reaction in both instances being a certain pressure per square inch upon a given area. It comes to the same thing, that you would get the same reaction in both instances, and that the speed of the ship, as I said just now, has nothing whatever to do with it. It is not slip nor is it loss of power at all. It is just the same as the stern chaser of a ship, the gun will recoil the same, and so the water will do exactly the same work, whether the vessel is going fifty miles an hour, or whether it is stationary.

Captain SIMPSON: I think I mentioned that you alter the size of the nozzles. My idea in altering the size of the discharge-pipes was this:—"I believe that if "the discharge-pipes in the 'Waterwitch' were increased to four times their pre-"sent area of 3,845 square inches, the result would be nearly as follows, that the "pressure at the back of the discharge-pipes due to the velocity of the discharge, "equal to the speed of the ship, or equal to fifteen feet per second, would be equal "to 12,000 lbs."

General BOILEAU, R.E., F.R.S.: If I may be permitted to make one observation as a landsman, it is in a mechanical point of view that I do so, not with the object of calling in question the design or principle which Captain Simpson has enunciated, because I do not quite comprehend the explanation which he has just given of the water entering into the turbine. The question that I would wish to put, is likely to illustrate to my mind and satisfy it on the point upon which there appears to be a difference of opinion between Admiral Elliot and Captain Simpson. One says—and I think with considerable truth as regards the mechanical question—that the engine is not necessarily the agent for supplying water into the turbine, because the pressure of the atmosphere would fill up any quantity of water that might be taken away, supposing, of course, that the water continued in contact with the sides of the vessel, therefore the engine power is not necessary to fill it. If, as the lecturer says, the engine power is necessary, and that the vessel going through the water with a certain velocity, the water would not enter through the orifice of the turbine, might I ask in case of a shot-hole being made in the side of a ship in action, and the ship is going at the rate of fifteen knots an hour, would the water enter the hole?

Captain SIMPSON: Of course it will.

General BOILEAU: Then the water must enter here.

Captain SIMPSON: You are talking of taking the water out with a bucket, or with your hand; and in that case you make yourself the engine if you lift the water up.

The CHAIRMAN: I think we must terminate this discussion, because we shall be getting into an irregularity in asking questions after the lecturer has concluded, particularly when we have got another subject to be brought forward. I believe, whatever our opinions may be, we must be grateful and thankful to the Lecturer for giving us this description, though we may not all agree with what he has said. There are some points in which I dare say some of us differ from him—at any rate we all feel enlightened by what he has said. Every invention brought before us must enlarge our ideas, and lead the way to other improvements, therefore I think we are very much obliged to Captain Simpson for his paper.

Captain SIMPSON: I must express my thanks for the manner in which you have given attention to my explanations.

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THE SPAKOWSKY MARINE AND ARMY NIGHT TELEGRAPH.

By Captain H. H. Dott.

The importance of a reliable and simple means of a speedy communication at night between vessels and military stations, is too well known by the officers of both branches of Her Majesty's service to require comment here.

In presenting the *Spakowsky Signal Light* to your notice, I do not seek, nor do I desire to make any innovations upon the code recently adopted by the Government, but simply to offer a powerful auxiliary to that system of communication.

The instrument which produces the light, weighs about 7lb. avoirdupois weight, is about 3ft. in length, and in shape resembles closely an ordinary civic mace, the resemblance to which is heightened by its being made of brass. Its staff, about 2in. diameter, is a hollow cylinder, inside which is fitted a piston that can be pressed down to two separate distances in the cylinder, but which, when not in use, is kept in the upper portion by a strong spiral spring in the lower part of the cylinder of staff. Immediately over the top of the piston, and at the upper part of the cylinder, is a projecting nozzle pipe through which the air finds entrance on the opening of a valve by drawing the piston downwards. The upper portion of the cylinder is now full of air, which will be driven out on the piston being released by the operator's hand, and being forced upward by the spiral spring underneath. In the upper portion of the instrument is a cotton wick, kept burning by a small spirit-of-wine lamp fixed in the head of the mace-like top. Opposite to the small flame of the spirit-lamp is about an inch of horizontally fixed brass tubing of about the thickness of whip-cord, terminating in a needle point from another piece of the same tubing—one being a continuation of the other—and pointing direct at the spirit flame. A reservoir in the head of the instrument contains a little over half a pint of petroleum, and this reservoir is connected with the two small pieces of tubing, and by means of them subsequently with the air from the cylinder below. The piston being released, is driven upward by the spring underneath, and forces the air through the small tubes in the face of the flame, and with it the petroleum in the form of a vapour. The result of this is, that a column of flame of full 2½ inches in diameter, darts upwards from the point of contact between the petroleum vapour and the flame of the lamp, and this column of light lasts just so long as the piston is moving upwards again to its normal position in the cylinder. The length of time during which the column of light is shown, depends therefore, upon the length to which the piston is pressed downwards in the cylinder. Thus a 2-inch movement of the piston may be said to give a short flash, and a 6-inch movement to give a long flash. A mechanical

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catch in the cylinder warns the signalman when he has reached the proper distance for a short or a long flash.

This light may be worked at all times, during high wind and rain, the flame being protected from these elements by a lantern, which covers the top of the lamp.

Permit me to briefly enumerate a few of the many advantages of this light.

1stly. Its ordinary strength and brilliancy, which, without the aid of a reflector or lens, is many times more powerful than any light hitherto known, and which, by the application of oxygen to its flame, may be made more brilliant than the oxy-calcium and other powerful lights which have been put aside, in consequence of the many disadvantages attending their use.

2ndly. It may be flashed from the deck or masthead of a vessel, and seen from all points of the compass at the same instant. For instance, a "general order" from the Commander-in-chief might be telegraphed from the masthead of the flag-ship, or head-quarters in the field, and be simultaneously received by the fleet, or the several divisions of an army.

3rdly. Its simplicity in construction and mode of operation will render it in the hands of any person endowed with ordinary intelligence, a safe and reliable medium of communication between ships, armies, coast-guard stations, and railways.

I have in the press an universal code of night signals for the Mercantile Marine (see Appendix), and I have full confidence that ere long (by means of this light), signals will be made at night, and understood by vessels of all nations.

For an account of a series of trials recently made with this light at Portsmouth, I beg to be permitted to quote from the London *Times*, of the 10th instant, as follows :—

Signal Lights.

A series of experimental trials have been made at Portsmouth during the past week, by order of the Admiralty, with a night signal-lamp which has just been introduced into this country, the results of which appear to promise what has long been wanted to perfect the night telegraphic system of her Majesty's fleets—a certain and reliable, economical, brilliant, and simply working flash-light. The light referred to as having been tried at Portsmouth appears to possess all the desired qualities as a flashing signal light. It has been introduced to the notice of our Admiralty by one of the inventors, a Captain H. H. Doty, and it is so far well known that it is now the signal light of the Imperial Navy of Russia. After submitting the apparatus to the inspection of the Board at Whitehall, Captain Doty proceeded, by their lordships' order, to Portsmouth, and on arrival there placed himself in communication with Admiral Sir Thomas Pasley, Port Admiral and Commander-in-Chief, to make arrangements for a thorough trial of his light. Sir Thomas Pasley appointed Captain Charles Fellowes, her Majesty's ship "Duke of Wellington," and Captain James G. Goodenough, her Majesty's ship "Minotaur," to carry out the trials of "the Spakowsky Marine and Army Night Telegraph," and report officially upon its results. On the first night of the trials, signalling was carried on after nine p.m. between the "Duke of Wellington," in Portsmouth harbour, and the "Minotaur," at Spithead, Captain Fellowes being provided with a Spakowsky lamp on board the "Duke," and Captain Goodenough on board the "Minotaur." The lights read and repeated the signals

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made from ship to ship with extraordinary clearness and quickness to the operators, and its success as a "light" simply and without regard to other considerations, which are rightly the province of Captains Fellowes and Goodenough to decide upon, was at once placed beyond a doubt. The second experiments were made for the purpose of examining some of the smaller details connected with the working of the light, and were made in the presence of Admiral Sir Thomas Pasley and other officers, and were also quite satisfactory. On Monday night last the paddle steam-tender "Sprightly," Master-Commander Allen, steamed out of Portsmouth harbour in the midst of a gale of wind and rain until outside the Nab Light-vessel, seven nautical miles from the Spit-buoy, and when there, carried on rapidly and freely a series of signals with the "Minotaur" frigate at Spithead, again proving the value of a good light to the new code. On Tuesday night Captain Fellowes and Captain Doty, by permission of Lieutenant-General Sir George Buller, K.C.B., took up a position on the ramparts of Fort Southwick, the central and most elevated of the Portsdown line of forts, and from there signalled for upwards of an hour with the "Minotaur," lying at Spithead. A dense haze lay on the water and over Portsmouth, between the fort and the frigate, but the petroleum lights penetrated through all, and delivered and received their messages without a check. It is, perhaps, necessary to observe that no night glasses of any kind were allowed to be used, nor were they required in reading a signal. The cost of its working can best be shown by an experiment made with it by Captain Fellowes, who, commencing with its reservoir newly filled with petroleum (a little over half a pint), flashed 1,470 long and 1,460 short flashes before the petroleum gave out. This would average about 400 words telegraphed, at under a shilling cost. This cheapness in working the light, and also in its purchase, would seem to indicate its suitability for a signal light for the mercantile marine. Supposing that two steamships were approaching each other at night, and the commanders of each wished to know the position of the other's helm, the long and short flashes of the signal light could at once ascertain it by spelling the words in the usual manner, or if there should not be time for that, to let the short flash stand for the short word, and the long flash for the long word—the short flash for "port," and the long flash for "starboard."

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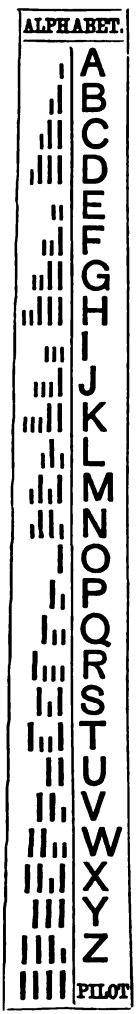
THE following code, referred to as being in the Press, which has been brought out to conform with, and as an auxiliary to, the Commercial Code of Signals, will explain the system of Flashes as they were exhibited before the meeting.—30*th December*, 1867. H. H. D.

DOTY'S

UNIVERSAL CODE FOR NIGHT SIGNALS, BY THE "SPAKOWSKY LIGHT."

An Auxiliary to the "Commercial Code of Signals."

(The Commercial Code has been adopted by the principal Governments of Europe and America.)



THIS "NIGHT SIGNAL LIGHT" is easily distinguished from all other Lights now in use; it presents a Columnar Flame of great brilliancy, which is exhibited in Short and Long Flashes; the Short Flash being about one second in duration, and the Long Flash about three seconds.

DIRECTIONS.

If you wish to correspond with a Vessel or Signal Station, you will first note the letters in the "Commercial Code," which may indicate what you desire to say; then proceed to flash the Short and Long Flashes as they are set (in this Table) until answered by the Vessel or Station called.

Call—A continued succession of Flashes -

Answer—A number of Long Flashes - - -

When answered, make the Flashes as they are set in the Alphabetical Column opposite the letters you may employ.

Example - (L) (R) (S)

Keep a Look-out for a Light—(See *Commercial Code*).

Yes—Three Long Flashes - - - - - - -

No—One Short, Two Long, and One Short - - - -

Repeat—(Repeat your Signals) - - - - -

Stop - - - - - - - - - - - - -

GENERAL SIGNALS.

Pilot—Call for a Pilot, Four Long - - - - -

Answer—Pilot's Answer - - - - -

To Avoid Collision.—On sighting a Vessel dangerously near, without being able to make out her course, flash—

Our Helm is Port—Continued Short Flashes -

Our Helm is Starboard—Ditto Short and Long

Distress—Alternately Three Long and Three Short Flashes - -

N.B.—The above simple "Code" may always be relied upon by observing the following

RULE.—The Flashes for the first letter should be repeated two or three times before proceeding to Flash the second letter, which latter should (in like manner) be repeated two or three times before Flashing the next, &c.

An interval of six or eight seconds should elapse between the Flashes for each letter.

H. H. DOTY.

ENTERED AT STATIONERS' HALL.

Distinguishing Letters

To denote the Nationality of the Vessel making the Signal, always to be given before the name of the Vessel, and to be followed by a number of quick Short Flashes, before flashing the letters for the Name.

E—England
F—France
R—Russia
P—Prussia
U—United States
I—Italy
A—Austria
T—Turkey
S—Spain
PL—Portugal
BM—Belgium
D—Denmark
H—Holland
N—Norway
SN—Sweden
B—Brazil
PU—Peru
C—Chili
G—Greece

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The Journal
OF THE
Royal United Service Institution.

VOL. XI. 1868. APPENDIX.

PROCEEDINGS OF THE THIRTY-SEVENTH ANNIVERSARY MEETING.

THE THIRTY-SEVENTH ANNIVERSARY MEETING of the Members was held in the Theatre of the Institution, on Saturday, the 7th March, 1868.

Major-General the Right Hon. Sir HENRY K. STORKS, G.C.B., G.C.M.G., Comptroller-in-Chief, War Office, in the Chair.

I. The Secretary read the Notice convening the Meeting.

II. The Minutes of the Proceedings of the Thirty-sixth Anniversary Meeting were read.

III. The Annual Report of the Council was read as follows:

1. THE COUNCIL have the pleasure of submitting their Thirty-seventh Annual Report.

MEMBERS.

2. One hundred and forty-one Members joined the Institution during the past year. The Council regret to record the loss by death of ninety-three, and by withdrawal of sixty-three. The names of fifty-three Members have been struck off the lists in consequence of the non-payment of their subscriptions due for two years and upwards, notwithstanding repeated applications. A detailed statement of the changes in the list of Members, and a tabular analysis of the past and present state of the Institution, will be found on pages 12 and 13.

FINANCE.

3. The usual Abstract of the Accounts for the Year, as audited on the 29th January, will be found on the following page.

In consequence of the large expenditure on the Journal, and in making arrangements for the protection of the building against fire, besides certain expenses for repairs, &c., the expenditure has exceeded the income, the balance of £53 6*s.* 11*d.* at the Bankers' being a portion of the Life Subscriptions which have since been invested.

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GENERAL ABSTRACT OF THE ACCOUNTS OF THE ROYAL UNITED SERVICE INSTITUTION, FROM 1st JANUARY TO 31st DECEMBER, 1867.

EXPENDITURE.

	£ s. d.	Amount £ s. d.
Secretary's Salary		250 0 0
Ditto Lodging Allowance		50 0 0
Librarian's Salary		100 0 0
Accountant's ditto...		100 0 0
Clerk's ditto		62 0 0
Servants' Wages		399 5 3
Ditto Clothing...		56 11 0
Ground Rent		202 1 6
Insurance...		20 5 0
Fuel		69 10 0
Lighting (includes quarter of last year)		48 16 1
Annuity to Porters Malcolm and Pitt		30 0 0
Assessed Taxes		80 8 1
Income ditto		4 13 6
Parish Rate for half-year, and Water Rate		68 0 0
Artificers, Repairs, &c.		286 10 4
Library		155 18 0
Museum		110 6 6
Lectures		53 11 0
Advertisements		45 1 9
Journals		927 6 9
Postage { Journals	158 12 4	
Postage { Letters	41 12 11	
		200 5 3
Printing Annual Report and List of Members		74 0 0
Printing Circulars and Stationery		92 14 0
Sundries		43 6 6
Balance of Petty Cash returned to Bankers		27 8 7
Total Expenditure		£3,557 19 1
Cash repaid to Agents		12 10 0
Charges from ditto		5 0 11
Cash returned to Captain Hans Busk		2 0 0
£133 11*s.* Invested in India Stock		143 8 0
£113 0*s.* 11*d.* ditto in Consols		104 0 0
Purchase of Exchequer Bills, March 6th		1,513 19 5
Balance at Bankers, 31st December, 1867		53 6 11
Total		£5,392 4 4

RECEIPTS.

	£ s. d.	Amount £ s. d.
Balance at Bankers, 31st December, 1866, Income ...		133 11 0
Annual Subscriptions, at 10*s.*, for 1867	555 13 0	
,, ,, above	1,837 15 6	
,, ,, arrears	27 0 0	
,, ,, advance	10 10 0	
		2,430 18 6
Entrance Fees		141 0 0
Dividends		185 19 2
Donation		1 0 0
Sale of Journals		95 4 9
Sale of Library Catalogue		2 15 0
Sale of Waterloo Pamphlets		0 12 6
Grant from Government		600 0 0
£1,500 Exchequer Bills Sold { May 7th	508 1 1	
£1,500 Exchequer Bills Sold { June 4th	508 7 1	
£1,500 Exchequer Bills Sold { December 3rd	503 10 0	
Interest on ditto	9 16 8	
		1,529 14 10
Balance of Petty Cash returned to Bankers		27 8 7
		£5,148 4 4
Balance of Life Subscriptions in hand, 31st December, 1866	36 0 0	
Life Subscriptions received during 1867	208 0 0	
		244 0 0
Total		£5,392 4 4

Examined and found correct, 20th January, 1868.

{ J. E. A. DOLBY, Capt.
J. D. MACQUEEN, Capt.
THOS. SMITH.

GEO. YELSTEAD, Accountant.

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Estimate of Probable Receipts and Expenditure for 1868.

Expenditure.	Amount. £	s.	d.	Receipts.	Amount. £	s.	d.
Secretary's Salary and Lodging allowance	300	0	0	Annual Subscriptions: £ s. d.			
Librarian's Salary ..	100	0	0	At 10s. .. 560 0 0			
Accountant's „	100	0	0	Above ..1,840 0 0			
Clerk's „	62	0	0		2,400	0	0
Servants' Wages	400	0	0	Entrance Fees	150	0	0
Ditto Clothing ..	50	0	0	Dividends and Interest ..	200	0	0
Insurance	20	5	0	Sale of Journals	80	0	0
Fuel	55	0	0		£2,830	0	0
Lighting	45	0	0				
Ground Rent	205	0	0	Grant from Government .	600	0	0
Annuity to Sergeant Pitt, late Porter	20	0	0				
Assessed Taxes & Income Tax	100	0	0				
Parish and Water Rates, including half-year for 1867	150	0	0				
Artificers, Repairs, &c. ..	150	0	0				
Library	150	0	0				
Journals	700	0	0				
Postage thereof	145	0	0				
Museum	150	0	0				
Topographical Room ..	5	0	0				
Advertisements	50	0	0				
Lectures	50	0	0				
Printing Annual Report and List of Members ..	90	0	0				
Printing Circulars & Stationery	90	0	0				
Postage	45	0	0				
Sundries	45	0	0				
Balance ..	152	15	0				
Total.. ..	£3,430	0	0	Total.. ..	£3,430	0	0

Life Subscriptions.

4. £208 were received during the year 1867, and there was a balance of £36 at the end of 1866, making a total of £244. Of this sum, £104 were invested in Three per Cent. Consols during 1867, and £140 (the balance) since 1st January, 1868.

Capital Account.

5. The funded property of the Institution was £5,485 19*s.* 3*d.* on the 1st of January, 1867. £246 11*s.* 11*d.* were added during that year, making a total of £5,732 11*s.* 2*d.* on the 1st January, 1868, since which date £151 11*s.* 2*d.* have been added, making the total at the present time, £5,884 2*s.* 4*d.*

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Lease of the Premises.

6. The arrangement for the approaches to the Thames Embankment being still incomplete, the Council are unable to give the Members any definite information on this subject. There appears little probability that any change will be made during the present year.

Lectures and Journal.

7. To those Officers and Gentlemen who by their Lectures and Papers during the past Session so ably contributed to the advancement and diffusion of professional knowledge, the Council tender their best thanks.

A glance at the contents of Vol. XI. of the Journal, will shew how numerous and varied were the subjects discussed in the Theatre of the Institution. That Volume exceeds those of any former years in the amount of its matter and the number of its illustrations. The Council have in consequence spent on the Journal a larger sum than usual, larger perhaps than the state of the finances of the Institution might appear to warrant. They do not, however, regret that expenditure, being firmly convinced that the objects of the Institution are best promoted, and its advantages most widely extended, by the circulation of carefully edited and liberally illustrated Papers and Discussions.

These facts induce the Council to hope that the Journal may receive from the two Services, as also from the general public, continued and increased support.

Library.

8. In the selection of books for purchase, no work of professional interest has, it is believed, been overlooked.

Among the valuable donations to the Library may be mentioned—

The Russian Military Journal, presented by the Minister-at-War at St. Petersburgh; two Military Works from the Prussian Government; one from that of the United States, and one from that of the Netherlands. The Italian Minister-at-War has presented two additional volumes of the *Giornale Militare* and the *Annuario Militare*; the Swedish Government, their Journal of the Military Sciences for the years 1864 and 1865. The exchange of Journals with the French and Austrian Governments has been continued.

The Secretaries of State for War, and for India, and the Lords Commissioners of the Admiralty, have kindly consented to supply for the Library of the Institution all Blue Books of interest relating to Naval and Military matters. The first-named Minister has forwarded a large number of Photographs, in continuation of the series presented last year, and of the Breech-loading Rifles submitted to Government for competition, as well as Lithographic Plates of articles manufactured at the Royal Arsenal, Woolwich.

The Lords of the Admiralty have granted a copy of all the Circulars issued by that Department for the years 1865-66-67, with instructions

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that they are to be supplied for the future. The Naval Members of the Institution will find these of much value for reference.

Through the kindness of the Lord Chancellor, an exchange of the Journal since its first publication, for the Series of Specifications of Patents of Firearms from 1617 to 1863 inclusive, has been effected with the Commissioners of Patents. These Specifications have been bound in forty volumes, and form a valuable addition to the Library.

The Committee of the United Service Club have presented a copy of the *London Gazette*, from 1687 to 1701, and from 1772 to 1796; and Major-General Black, R.A., (Madras,) the Madras Artillery Records, from 1838 to 1862, bound in seventeen volumes.

The Library now contains 13,800 volumes.

Topographical Department.

9. The utility of this department has much increased, as evidenced by the fact that more frequent reference is made by Members to the valuable collection of Maps, Charts, and Plans.

The Secretary of State for War has presented the Institution with the compilation entitled, "Routes in Abyssinia," together with the Maps relating thereto, executed at the Topographical Department of the War Office. These and other Maps of the country have been hung up on the walls in the Topographical Room, and the position of the expeditionary force marked off as usual from time to time for the convenience of the Members. Forty-three Books and Charts have been received from the Admiralty.

The Belgian Minister-at-War has forwarded three sheets of the Topographical Map of Belgium, for which the Council have expressed their thanks.

Captain Hope, R.N., has presented Four Maps of portions of New Zealand; and Major Wright, A.D.C. to General von Moltke, a valuable Series of Plans (twenty-three in number) of the Battle-fields of the late War in Germany, together with the first two parts of the official work on the campaign.

Major Wright had previously been elected an Honorary Member of the Institution.

Museum.

10. The following additions by presentation to the Museum require special notice:—From the Secretary of State for War, a series of common shell, whole, and in section, for the 9, 8, and 7-inch muzzle loading guns; specimens of double shell, whole and in section; of shell, whole and in section, for the 64-pounder; and of 9, 8, and 7-inch Palliser chilled shell, with specimens of castings, chilled and in sand: from the proprietors, the Cockran breech-loading rifle: from Major-General Sir Vincent Eyre, K.C.S.I., a coat of quilted armour, taken in action from Koer Sing, the famous Rajpoot Chief of Jugdeespoor: from Captain Trotter, three topographical models, two of which,—the celebrated pass of the Simplon, and the city of Geneva with the old fortifications, are of much interest.

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The following additions have been made by purchase—Specimens of breech-loading rifles, viz.: the Burton, Albini Braendlin, Montstorm and Selwyn, Henry, Fosbery, and Chassepôt. The collection of breech-loaders in the Museum now numbers forty-nine different patterns. A quarter-size model of a 10-inch Woolwich gun has been added to the other models of heavy ordnance.

A complete list of the additions to the various departments will be found in the Appendix to Vol. XI. of the Journal.

By the kind assistance of Colonel Walker, Military Attaché to the British Embassy at Berlin, the COUNCIL have secured a correct and well-executed copy of the model of "The Battle-field of Königgratz," which was completed last year under the superintendence of the Prussian War Department. The horizontal scale of the model is $\frac{1}{10,000}$, the vertical $\frac{1}{2000}$. The positions of the contending armies will be marked out as soon as all the official accounts of the battle have been published. The COUNCIL congratulate the Members on this valuable acquisition to the Model Room of the Institution.

The thanks of the COUNCIL have been tendered to the Secretaries of State for War and for India, and to the Lords of the Admiralty, for their respective contributions to the Institution.

CORRESPONDING MEMBERS.

11. The number of Corresponding Members on the 1st January, 1868, was 213, as compared with 218 on the 1st January, 1867. The COUNCIL would again suggest, that in each Regiment and Ship in which there is no Corresponding Member, one of the Members of the Institution should volunteer his services to fill that post.

CONCLUSION.

12. The COUNCIL observe with regret a decrease of sixty-eight in the number of the Members during the past year. The income of the Institution has not suffered up to the present time; but the COUNCIL feel that they have only as yet obtained the support of a small proportion of the officers of both services who might reasonably be expected to join the Institution. They have had under their anxious consideration various schemes for adding to its utility and increasing its popularity. They hope to be able to report further on this subject at the next Annual General Meeting. In the meantime they invite the hearty co-operation of individual Members who may do good service by making known as widely as possible the objects and advantages of the Institution.

General The Hon. Sir EDWARD CUST, G.C.L., K.C.H.—

Sir Henry Storks and Gentlemen. The duty that has been assigned me to perform is to move:—

"That the Report now read be adopted and printed for circulation among the Members."

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The first matter that comes before us for observation is not a very gratifying one, viz., a diminution in the number of Members. Why it should have occurred to the extent it has done, seems to me to be rather inexplicable. At all events, the circumstance ought to be a further inducement to us to exert ourselves among our friends, our young friends especially, to endeavour to get them to join the Institution. The next paragraph in the Report to which I would call attention, is one that is also not very favourable, viz., the state of the finances. However, I am told, that that is to a certain extent to be explained by the additional expense which has been incurred in connection with the *Journal*, and other matters that are named in the Report. I would here especially allude to the *Journal*, because I do not think that the expense, as incurred by the Institution, bears anything like a proportion to the value of the *Journal* to the public. (Hear, hear.) It is not only the papers that are read, and which are drawn up with admirable ability, but it is the discussions which frequently follow the reading of the papers, which give so much value to the *Journal*. The discussions very much illustrate the paper read, and bring out information that may be of great advantage hereafter; and the *Journal*, as a record of what has been introduced in military and naval science, may prove of great service when we come to test the question of the priority of any given invention. There is no other mode existing that I know of which provides for this; and this prevents our discussions being idle and profitless ones. With reference to the *Journal* of last year, my attention was attracted to a paper by Major Fosbery, on the Umbeylah Campaign. I am ashamed to confess that I was ignorant of the name of the Umbeylah Campaign until I began to read that paper. I see that Major Fosbery, who is one of the gallant possessors of the Victoria Cross, makes an apology for introducing a campaign that might be so little known. It is the advantage of the *Journal* that it perpetuates a record of these minor events, but which are really of great importance to military history. It reminds me of an instance that occurred to myself lately, in connection with my own pursuit in writing the Lives of the great campaigners of former days. I was engaged with Field-Marshal Schomberg's Campaigns, and I could not find in any English history notice of a campaign in which Marshal Schomberg acted in command of English troops, who behaved with such great distinction, as to make us really proud of them. The first notice that I got of it, was in conversation with a foreign gentleman, who lent me a Portuguese history. I also found that another foreigner, a celebrated man, General Dumouriez, who had been long resident in England, had written an account of this campaign in which English troops had so distinguished themselves, but it had slipped altogether out of English history, and I was obliged to collate the facts from the State Paper Office. In the prodigality of our glory, there seems little disposition or care to preserve the records of these little wars. It was, however, an exceedingly remarkable one. It lasted five or six years, and took place just at the close of the Commonwealth, and at the time of the Restoration of Charles II. To such an extent did our national reputation gain by those campaigns, that have been so little recorded by ourselves, that I may allude to a circumstance, and rather a comical one, which may interest you. The English were so successful in the south, and the Portuguese so unsuccessful in the north, that a happy idea struck the Portuguese Commander in the north. He put his soldiers into scarlet flannel, in order that they might appear to be British troops, and I am happy to say that the *ruse* succeeded. The Spaniards, under the apprehension of an assault from the British, gave up the post.

I will not further allude to any part of the Report, except to one paragraph, which affords us some comfort under the loss of Members, and the diminution of finances. I am glad to observe that we do not lose the kindness of our friends; the gifts that have been made to us by persons in authority, Naval and Military, and the assistance given to us by others in contributing to the Museum and Library is a gratifying circumstance, as showing that this Institution is held in high estimation, and that it will continue to prosper.

Commander COLOMB, R.N.—

I have very much pleasure in seconding the resolution. I myself do not think that we need be very much surprised at the diminution of Members, because we

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must recollect that there has been a tightness in the money market this year, and prospective Members have no doubt suffered like everybody else; the small subscription also, small as it is, affects the pockets of many men who would be glad to become Members of the Institution. In speaking of the Lectures and the *Journal*, I think that the publication of the *Journal*, in one way affects the joining of Members, because existing Members lend the *Journal* to their friends; and these say, "It is no use our belonging to the Institution, we can get all the information we want from the *Journal*." At the same time the *Journal* has the effect of raising the *status* of the Institution generally, not only in England, but abroad. I have communications from time to time with Foreign Officers, especially of late, and I have been quite surprised to see what a very high standing the *Journal* of this Institution enjoys abroad. A curious circumstance came under my notice recently, viz., that papers published in the *Journal* of this Institution are translated into foreign languages, and are being sold on the continent in the form of separate pamphlets. No doubt the publishers make a good thing of it. This fact shows the value of the *Journal*, and the great standing that the Institution has gained. As regards the lectures and discussions, I have been a constant attendant at them, and one thing has struck me forcibly of late years, viz., the increased value of the discussions. Members recently have been in the habit of preparing themselves better for the discussions than they did when I first joined the Institution. The consequence is, that at these discussions we get a number of most valuable remarks,—remarks which you can carry away, and think over afterwards. I think it also speaks well for the Institution, that a collection of breech-loading rifles should have been so well got together and also so well looked after: the collection is really a most valuable one; and you seldom come into the Museum without seeing a crowd of inquiring minds surrounding the glass cases in which the rifles are kept, and inspecting them carefully. I will not make any further remarks, but will conclude by seconding the resolution.

The Motion was put from the Chair and carried unanimously.

The names of the eight Members retiring from the Council by rotation, were read as follows:—

Captain E. PACKE, late Royal Horse Guards.
Captain H. W. TYLER, late Royal Engineers.
Rear-Admiral Sir John C. D. HAY, Bart., M.P.
Lieut.-Colonel A. C., COOKE, Royal Engineers, C.B.
Lieut.-Colonel J. H. LE COUTEUR, Coldstream Guards.
Captain R. HALL, R.N.
W. F. HIGGINS, Esq.
Rear-Admiral E. G. FANSHAWE.

Major-General the Right Hon. F. PLUNKET DUNNE, M.P.—

General Storks, My Lords and Gentlemen. I have been entrusted with a motion which I am sure you will all agree to. It is:—

"That the thanks of this Meeting be given to the Members of the Council who retire by rotation, and that the following Members be elected to fill the vacancies:—

For Re-election.

Rear-Admiral Sir John C. D. HAY, Bart., M.P.
Lieut.-Colonel A. C. COOKE, Royal Engineers.
W. F. HIGGINS, Esq.
JOHN BARROW, Esq., F.R.S.
Colonel H. F. PONSONBY, Grenadier Guards.
Rear-Admiral A. C. KEY, C.B.
Major G. H. A. FORBES, R.A.
Captain J. D. MACQUEEN.

And that the following names be adopted, from which to select in the event of vacancies occurring in the Council:—

Captain Lord FREDERICK H. KERR, R.N.
Captain H. W. TYLER, late Royal Engineers.
Lieut.-Colonel The Hon. E. LEGGE, Coldstream Guards."

Without the exertions of the Members of the Council, you could not have that

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efficiency in the Institution which has increasingly marked its career for many years past, unless you paid for it in some way very seriously indeed. I think you have had a most satisfactory explanation from the gallant Officer who seconded the first Resolution, that taking it altogether, there is nothing more in the statements of the Report than may be attributable to those alterations which will happen with all Societies as with individuals. There are two points that have not been mentioned, which I will just say a word upon. One is the Topographical Department. That has been greatly improved. A few years ago, such a Department did not exist in the Society; now it seems to be becoming a most useful part of the Institution. The other point is "the Corresponding Members." I believe if the system of Corresponding Members were to be extended, it would prove of great utility. Small plans of positions, and of the contour of the country in distant lands in which military men are employed, would be of great service. Take Abyssinia for instance; if some of our Officers had been in that country, how closely every plan or position of theirs would have been looked into. I think we ought to impress upon the Officers of the Two Services the necessity and the advantage of sending home even the slightest plans and sketches that can be made. Whenever I have had the opportunity of addressing the Members of this Institution, I have always pointed out the value of this practice. It is stated that the Army is to be filled with highly educated men. I hope that we shall see more of these men in the army; at present I confess I am disappointed that our highly educated young men have not joined the Army in the numbers that I expected they would do. I will conclude by moving the Resolution that I have read.

Admiral Sir E. BELCHER, K.C.B.—

I have great pleasure in seconding this motion. I do not know that I can add anything to what the gallant mover has said, except that the Public Offices should give us copies of the military and naval records that they receive. I think we are more likely to get them in that manner than from Officers themselves.

The Motion was put from the Chair and carried unanimously.

Lieut.-Colonel GOSSET, R.E.—

Sir,—When funds have to be expended, it is right and proper, towards those gentlemen who have the control of the expenditure, and towards the Members of the Institution, that the most rigid scrutiny should be exercised, and that the accounts should be audited with the greatest precision. The duties of an auditor are not particularly agreeable; they are rather of a troublesome character, and require care. They are, however, most valuable and important duties, and it is but right and proper that they should be duly recognized and acknowledged. I have therefore the honour to move—

"That the thanks of this Meeting be given to the auditors for their valuable services, and that the following gentlemen be elected for the ensuing year:—

H. F. DOWNES, Esq., for Re-election.
THOMAS SMITH, Esq.
Captain J. E. A. DOLBY."

MONTAGUE CHAMBERS, Esq., Q.C., M.P.—

I rise with very great pleasure to second this resolution, by the permission and direction of the Council. These words I utter, because probably I am little known to many of the veterans and to but few of the younger officers here present. The only apology I can make is this, that from my earliest youth I have had an attachment to the two Services. My connections and relationships have blended all my ideas with their prosperity; and I have been for some time a Member of this great, rising, and national Institution. When I had the pleasure, upon a former occasion, of addressing a similar Meeting, I suggested that we had begun, as all great institutions, if they intend to prosper, should begin. We began with modesty, we began with resolution, we began with determination by our own exertions if pos-

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sible, to achieve success. Success we have achieved, but we have not reached the very pinnacle of our greatness; there is still much to be done. I have listened with the deepest interest to the observations that have been made with reference to the Report that has been presented to-day. It is not altogether favourable, yet we may not be without hope that that which occurs to-day will give a new zest to those who are Members of the Institution, and be a great inducement to others, who hear how we are getting on, to become Members. It ought to be an Institution which every Officer, Naval and Military, should struggle, if possible, to support in every possible way. Now, there is one subject that I think is very fairly *apropos* to the motion that I second; I mean the subject of finances. Some observations have been made with reference to what is called "the tightness of the money market," and it is said that even we have been affected by it, in consequence of subscriptions not coming in so readily as might have been expected, and new subscribers not being obtained. I hope the effect has not gone so far, as to intimidate those who would have become Members from doing so, but that when they hear of our generally prosperous condition they will be prepared to enrol their names during this current year. But perhaps I may be forgiven if I allude to a subject which is to us of the deepest possible importance. I have read in one of the paragraphs of this Report that we are but uncertain tenants at will of this very useful building; that upon very short notice we may be required to quit. Therefore, as coupled with our financial arrangements, although we have a very considerable balance invested, surely it would be desirable, if I may adopt a naval expression, "to look ahead," to anticipate what may come, to be prepared when the occurrence takes place; so that we may not sink suddenly or be unable to find any resting place. I merely therefore suggest that it would be desirable at the present moment—I hope the Members will take into their consideration whether I am right or wrong—to look out for some spot, whilst we can obtain it, where we may erect a new building, or get some old building into which we may move. I have it from a suggestion that has been made to me by an authority, whom I am not at liberty to name, and perhaps it might be followed out by those who manage this Institution so extremely well, that if we are to build a new building, we might get a spot in front of the river, near to the embankment. The spot that we have now is very eligible, very excellent indeed; but if by possibility we could enter into some negotiations for the purpose of obtaining a spot,—if we are compelled to remove, perhaps the Council would not consider a site on the banks of the Thames an inappropriate one for any new building we may have to erect. As to the management of our finances, it is with great pleasure that I am able to refer to the account presented to us, and to contrast it with certain accounts that one occasionally reads of in the newspapers. Unfortunately, all Auditors have not the same high character, nor have they so well earned the high character as careful Auditors as those gentlemen to whom we are about to give our thanks. These gentlemen seem most carefully to have investigated the accounts, and I daresay we shall never be shown up in public except in those words of praise which I hope all who are present will now join in, namely, a vote of thanks to the Auditors for their services to this Institution.

Major-General The Hon. JAMES LINDSAY—

Before you put the motion, Sir, it would be right that I should say a few words on the subject which the hon. gentleman has just now mentioned. It might be as well that the Members of the Institution should understand—I will not say, exactly, for I do not know that my memory can carry me back into the whole transaction—at any rate should have a tolerably fair understanding as to the position of this Institution with respect to the Government and the Thames Embankment. What has been done is this—about five or six years ago, when the Thames Embankment was suggested, and the Committee which sat upon the question, made their Report to both Houses of Parliament, a deputation from the Committee of this Institution waited upon the Chancellor of the Exchequer—I think it was—with the view of securing to ourselves the site where we are at present located. And though I believe that nothing is really settled now, with regard to the approaches to the Thames Embankment, yet the general understanding was this, that Whitehall Yard would be

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one approach to the Thames Embankment, and that by the removal of Lord Carington's house there would be a grand approach to the Thames Embankment opposite to the Horse Guards. The Government received our deputation in a way satisfactory to ourselves. We communicated also with the architect to the Government, who lives next door. Though I cannot exactly say that any direct and decided pledge was absolutely given, yet, at any rate, it is a fair understanding between us and the Government that we are to remain where we are; and further than that, that we can have more ground towards the river, supposing that we want it; but upon the understanding that we erect a new front to our building that shall be an ornament to the new street, and generally acceptable to those who have the management of public affairs. I may therefore safely say, I think in this public way, that we have an understanding with the Government, that we are to remain where we are, subject, of course, to the production of a building that shall be creditable to the Institution as well as to the Metropolis.

The Motion was then put from the Chair and carried unanimously.

The CHAIRMAN then announced that the business of the Meeting was concluded.

The Chair having been taken by Major-General LINDSAY.

Colonel SYKES, M.P., said—

I have a very agreeable duty imposed upon me, viz., to offer the thanks of this Meeting to the distinguished Officer who has presided over us on this occasion. I hope it is a good augury for the future consideration, support and patronage of one now placed in a situation of high responsibility and trust, and which cannot fail to be advantageous to us, if exercised with kindly feeling on his part towards the objects of this Institution. That our objects are useful I think my right hon. friend will be disposed to admit, without the slightest hesitation. During thirty-six years, we have gone on accumulating Models, a professional Library, and various specimens of professional art, which have been most useful for reference and for study, not only by the Two Services, but by the Public at large. Setting aside the advantages which the services have derived from the comparatively recently established *Journal*, which you have heard has obtained not only an English, but an European reputation, I think that these coincident circumstances will have satisfied my right hon. friend that really the Institution is deserving of his future support and consideration. And as on this occasion we have had the advantage of his presidency, so we also hope that on some future occasion we shall have proofs that his attendance here this day has been operative upon his own mind with regard to the future advantage and prospects of the Institution. I therefore ask you, gentlemen, to give a unanimous vote of thanks to an Officer who has distinguished himself equally in his profession and in his civil duties as an Officer of the State, for having presided upon this occasion.

Rear-Admiral OMMANNEY, C.B.—

I have great pleasure in seconding the motion. I can only reiterate the hope just expressed by the gallant Colonel, that the services of Sir Henry Storks, so well known to the country, may in his more leisure time be extended to the encouragement and promotion of the interests of this Institution.

The Motion was carried with acclamation.

Major-General Sir H. STORKS—

Gentlemen. I beg to return you my best thanks for the honour you have done me in passing the Resolution that has been put from the chair. I can assure you it was with very great satisfaction that I accepted the invitation of the Council to preside over this General Meeting to-day, because I wish to take an active part in the transaction of the business of this Institution, which I have hitherto been precluded from doing by a long period of foreign service; and also because I wish to express

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publicly, the great interest which I take in the prosperity and usefulness of this great Institution. Having been a great deal abroad, and having been somewhat in communication with Foreign Armies, I can confirm all that has been said by the hon. and gallant gentleman who seconded the first resolution, as to the high estimation in which the *Journal* of the proceedings of this Institution is regarded by officers of those Armies. Articles are translated, and constant reference is made to them; and on more than one occasion I have been asked to explain the objects and the nature of the Royal United Service Institution. I therefore think that any money that has been spent in the publication of the *Journal* was money well laid out, and that it cannot fail to produce very good results as regards the prosperity of the Institution. I would also venture to make one more observation with respect to the promotion of the interests and prosperity of the Institution—that is, that every effort should be made to increase the number of Corresponding Members, and that those Corresponding Members should be encouraged to canvass, if I may say so, for subscribers to the Institution. I am quite sure that in many foreign stations, the Institution is not sufficiently known; and that nothing would add so much to its prosperity and welfare, as greater publicity. As regards the Report which we have had read to-day, I think there is no need for apprehension as to our future success and prosperity. (Hear, hear.) Fluctuations occur in all establishments, and no doubt we are affected like others. But I am sure that everything promises well for the future. Gentlemen, I can only again thank you for the honour you have done me on this occasion; and I can only repeat, which I do most sincerely, that it will be my endeavour, at all times and under all circumstances, to assist to the best of my ability the interests of this great Institution.

STATEMENT OF CHANGES AMONG THE MEMBERS SINCE 1ST JANUARY, 1867.

	Life.	Annual.	Total.
Number of Members, 31st December, 1866 ..	885	3,006	3,891
„ „ . joined during 1867 ..	12	129	141
	897	3,135	4,032
Changed from annual to Life	+13	−13	
	910	3,122	
Deduct—Deaths during 1867 ..	27	66	
Withdrawals ..		63	
Struck off		53	
	27	182	209
Number of Members on 1st January, 1868 ..	883	2,940	3,823

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Tabular Analysis of the State of the Institution,

To 31st of December, 1867.

Year. 1st Jan. to 31st Dec.	Annual Subs. received.	Entrance Fees.	Income (from all sources).*	Life Subs. received.	Amount of Stock.	Invested in the purchase of Books, &c.	No. of Vols. in Library.	No. of Members on the 31st Dec.	Number of Visitors
	£	£	£	£	£	£			
1831	654	..	654	1,194	..	..	..	1,437	..
1832	1,146	..	1,146	973	..	..	..	2,699	..
1833	1,405	..	1,450	692	..	..	..	3,341	..
1834	1,500	..	1,549	583	1,100	..	..	3,748	13,376
1835	1,480	..	1,574	366	2,480	40	..	4,155	8,537
1836	1,570	..	1,682	330	3,747	45	..	4,069	8,521
1837	1,549	..	1,747	222	4,747	180	..	4,164	10,907
1838	1,462	..	1,634	230	5,500	246	..	4,175	15,788
1839	1,399	..	1,565	168	5,500	292	..	4,186	16,248
1840	1,363	..	1,525	198	5,500	446	5,500	4,257	17,120
1841	1,450	..	1,643	186	6,000	243	5,850	4,243	19,421
1842	1,373	..	1,565	144	6,400	373	6,450	4,127	21,552
1843	1,299	..	1,494	140	6,700	237	7,000	4,078	27,056
1844	1,274	..	1,408	112	3,000	298	7,850	3,968	22,767
1845	1,313	..	1,466	228	1,500	127	8,100	3,988	21,627
1846	1,298	..	1,456	138	1,500	74	8,410	4,031	32,885
1847	1,314	74	1,502	132	1,700	37	..	4,017	38,699
1848	1,175	57	1,375	48	1,700	85	9,641	3,947	37,140
1849	1,176	72	1,375	84	1,150	58	..	3,970	33,333
1850	1,141	106	1,294	198	600	36	..	3,998	33,773
1851	1,136	131	1,292	66	666	34	10,150	3,188	52,173
1852	1,134	133	1,281	114	200	43	10,300	3,078	20,609
1853	1,243	319	1,684	264	528	41	10,420	3,251	25,952
1854	1,200	138	1,368	126	612	95	10,587	3,171	22,661
1855	1,159	107	1,289	120	653	55	10,780	3,131	14,778
1856	1,216	197	1,519	156	761	47	10,832	3,204	16,184
1857	1,258	176	1,937	78	1,038	40	10,960	3,168	12,755
1858	1,318	221	2,102	105	488	31	11,062	3,246	25,747
1859	1,526	195	2,277	512	946	70	11,320	3,344	28,739
1860	1,961	298	3,577	397	2,178	114	11,517	3,518	28,011
1861	2,122	305	2,899	266	2,846	99	11,812	3,689	23,296
1862	2,296	242	3,127	239	3,178	109	12,026	3,797	27,215
1863	2,379	218	3,100	405	3,583	143	12,296	3,847	18,150
1864	2,425	215	3,253	222	4,516	116	12,700	3,902	17,276
1865	2,435	154	3,467	235	4,804	137	13,000	3,895	18,253
1866	2,435	157	3,488	299	5,486	150	13,337	3,891	17,067
1867	2,431	141	3,467	208	5,732	140	13,800	3,823	17,211

* Including Annual Subscriptions, Entrance Fees, Donations, Legacies, and Interest on Funded Property; and also the Grant from Government, commencing in 1857.

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DONATION IN 1867.

Doughty Chester, Captain 23rd R. W. Fusiliers, £1.

NAMES OF MEMBERS

WHO JOINED THE INSTITUTION BETWEEN THE 24TH JUNE AND 31ST DECEMBER, 1867.

LIFE.

Smith, N. Bowden, Commr. R.N., 9*l*.
Stewart, Duncan, Lieut. R.N., 9*l*.
McNeile, Alexr., Capt. h.p. Indian Army, 9*l*.
Keppel, Edw. Geo., Ens. 74th Highrs., 9*l*.
Cooke, Wm., Ens. 10th Regt., 9*l*.
Rudge, John, Capt. 10th Regt., 9*l*.
Johnson, Geo. V., Col. R.H.A., 9*l*.

ANNUAL.

Wilson, Fred. W., Capt. R.N., 1*l*.
Aveland, Lord, Lord-Lieut. Lincolnshire, 1*l*.
Whalley, J. L., Capt. 1st Royal Lancashire Mil., 1*l*.
Sanders, C. D., Comr. R.N.
Litchford, E. B., Lieut. late 48th B.N.I.
Marsden, Richd., Lieut. R.N.R., 1*l*.
Boyle, E. R., Lieut. Coldm. Gds., 1*l*.
Cooper, J. C., Capt. 8th or King's, 1*l*.
Streatfield, S. R., Lieut. late R.N., 1*l*.
Boys, Henry, Capt. R.N., 1*l*.
Smith, Michael W., C.B., Major-Gen. unatt., 1*l*.
Chesney, G. T., Major R.E., 1*l*.
Villiers, Hon. G. P. H., Lieut. Gr. Gds., 1*l*.
Montgomerie, Hon. G. A., Lieut. Gr. Gds., 1*l*.
Henderson, Joseph, Cornet 12th Roy. Lancers, 1*l*.
Parker, Francis, Cornet 12th Roy. Lancers, 1*l*.
Stephens, Cecil J., Cornet 12th Roy. Lancers, 1*l*.
Firebrace, F., Lieut. R.E., 1*l*.
Phillpotts, W. C., Capt. R.E.
Hall, Richd., M.D., Asst.-Surg., 33rd Regt., 1*l*.
Andoe, Hilary G., Lieut. R.N., 1*l*.
Wilmot, W. A. Eardley, Lieut. 5th Fus., 1*l*.
Thomas, W. H., Ens. 1st Surrey Rifle Vols., 1*l*.
Ross, W. Alexr., Major Royal Art., 1*l*.
Doughty, Chester, Capt. 23rd R. W. Fus., 1*l*.
Heyland, Herbert, Mid. R.N., 1*l*.
Chichester, H. A., Ensign 25th K. O. Bors., 1*l*.
Thurlow, H. H., Ens. 13th L. I.
Lloyd, The Revd. W. V., M.A., F.R.G.S., Naval Instructor, 1*l*.
Grenall, Fred. H., Lieut. 15th Regt.
Mush, John, Lieut. 17th Regt., 1*l*.
Chater, Sidney, Surg. London Rifle Brigade Volrs., 1*l*.
Hare, R. D., Lieut. late 9th Regt., 1*l*.
Harding, Charles, F.R.S.L., F.R.G.S., F.S.S., F.A.S.L., Capt. 19th Surrey Rifle Vols., 1*l*.
Mackey, H. A., Lieut. R.A., 1*l*.
Seton, J. L., Capt. 102nd Royal Mad. Fus., 1*l*.
Cleland, Wm., Lieut. 102nd Royal Mad. Fus., 1*l*.
Sandeman, J. E., Lieut. Beng. Staff Corps, 1*l*.
Bland, J. Fox, Capt. 76th Regt., 1*l*.
Lawler, D. A. S., Lieut. 13th L. I., 1*l*.
Corcasden, J. F., Capt. Queen's West. Rifle Vols., 1*l*.
Melgund, G. J. Viscount, Lieut. Sco. Fus. Gds., 1*l*.
Scott, Beauchamp H. J., Lieut. Sco. Fus. Gds., 1*l*.
Clarke, J. H. C., Ens. 7th Fus. 1*l*.
Boswell, G. L. H., Lieut. Gr. Gds.
Langford, H. E. Lord, Lieut. Gr. Gds.
Cotes, C. J., Lieut. Gr. Gds.
Pearce, George G., Major R.A., 1*l*.
Carmichael, J. D., C.B., Col. 94th Regt.
Phillips, E. B., Capt. late 53rd Regt.
Richards, John, Navigating Lieut. R.N. 1*l*.
Hawes, Geo. H., Lt.-Col. 9th Regt., 1*l*.
Tulloh, J. S., Major R. H. A., 1*l*.
Prynne, John B., Major R. M. L. I. 1*l*.

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ADDITIONS TO THE LIBRARY AND MUSEUM DURING 1867.

LIBRARY.

BOOKS PRESENTED.

ABYSSINIA. Routes in Abyssinia, with two Appendices. Pamph. 8vo. 1867. 2 copies.

ADMIRALTY Circulars for 1865-66 and 1867.
The Lords Commissioners of the Admiralty.

ALCOCK, T., Lieut.-Colonel. The Militia, the Nucleus of our Defensive Force. Pamph. 8vo. London, 1867.
The Author.

ANNUAL Report on the Instruction carried on at the Schools of Musketry at Hythe and Fleetwood, and of the progress of Musketry Instruction in the Army, during the year ending 31st March, 1866. 8vo. London.
Lieut.-General C. C. Hay.

ANNUARIO Militare del regno d' Italia, 1867. 8vo. Firenze, 1867.
Italian Minister at War.

ARMY of Great Britain, Strength, Composition, and Organization of. 1867-68. 5th Ed. 2 copies.
The Secretary of State for War.

ARMY List, Official Annual, for 1867-68. 8vo. London.
The Secretary of State for War.

ARTILLERIE-Unterricht für die Mannschaft der-Festungs und Kusten Artillerie Compagnien. 2 Parts. 12mo. Wien, 1866.

Unterricht für die Mannschaft der Batterien und Park-Compagnien. 12mo. Wien, 1866.

Instruckzion über die Beschaffenheit, und die Ausrustung der 4 und 8 psundigen feldgeschutz vom Jahre 1863. 8vo. Wien, 1864.

Provisorische Instruckzion über die Einrichtung und den Gebrauch der Rotazions Raketen. Pamph. 8vo. 1865.
Captain Muller, I. Austrian Engineers.

Ueber die von der Artillerie-Prüfungs - Kommission ausgeführten

ARTILLERIE—*continued.*

Schiessversuche gegen Schiffspanzer. 8vo. Berlin, 1867.

Bericht über die Schiessversuche gegen den gepanzerten Schumann' schen Geschützstand. 8vo. Berlin, 1867. *The Prussian Government.*

ATHENÆUM Club. Supplement to the Catalogue of the Library of the Athenæum, printed in 1845; with a Classified Index of Subjects. 8vo. London, 1851. *The Committee.*

BAKEWELL, F. C. A Dynamical Theory of the Figure of the Earth. Pamph. 8vo. London, 1867.
The Author.

BALFOUR, G., Major-General, C.B., R.A. The Military Conscription of France. From the Journal of the Statistical Society of London. June, 1867. Pamph. 8vo. London, 1867.
The Author.

BEDFORD, E. J., Captain R.N. Code of Uniformity in the Colour of Buoys. Pamph. Folio. 1867.
The Author.

BENGAL Military Repository. 5 vols. 8vo. Calcutta, 1822.
Major-General Sir V. Eyre. K.C.S.I., C.B.

BERENGER, R., Esq. The History and Art of Horsemanship. 2 vols. 4to. 1771. *Colonel Wigram.*

BETHUNE, Admiral, C.B. Instructions for using Admiral Bethune's Night Signals. Pamph. 8vo. 1861. 2 copies.

Memorandum on Signals for the use of the Merchant Service. 4to. 1855. *The Author.*

BEWSHER, B., Lieutenant, late I.N., Surveyor in Mesopotamia. Memoir on Part of Mesopotamia contained between Sheriat-el-Beytha on the Tigris to Tel Ibrahim. Pamph. Folio. 1865.

Chart of Trigonometrical Survey of above. 1 sheet. *The Author.*

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BIGSBY, Robert, LL.D. A Tribute to the Memory of Scanderbeg the Great. Pamph. 8vo. London, 1866.
The Author.

BLUE BOOKS:

Jamaica. Copy of Extracts of Correspondence between the Horse Guards and General O'Connor, on the Conduct of Military Officers during the recent deplorable occurrences in Jamaica. Folio. 1867.

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Dagger of Oriental manufacture.
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Pattern II. Naval.
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Cartridges for Snider's Breech-loading Rifle. *Colonel Boxer, R.A.*

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Model of a 32-pounder Gun, throwing a sharp-edged discoidally-formed shot.
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Section of 12-pounder Gun, showing his mode of strengthening by means of an internal wrought-iron tube.

Small Model of 12-inch Gun, showing mode of inserting tube.

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1 9-inch Palliser Shell.

1 do. do. broken open to show grain of metal.

1 Screw Bolt for attaching armour plates, adopted in iron shields for permanent fortifications.
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1 Short African Spear.
4 Long do. do.
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No. 1. Small Ordinary Screw Bolt.
„ 2. Do. do. broken off by first blow of 28 lbs. weight, falling through 2 feet.
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Screw Bolt with reduced shank after test. This bolt withstood nine blows of the 28 lbs. weight, falling through 2 feet 6 inches. Before being tested, its length was the same as that of Nos. 1 and 3.

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Steel Model of a Mackay solid shot.
77-lb. shot fired on 13th November, 1867, from the Mackay 8·$\frac{18}{100}$ Windage Gun, with a charge of 30 lbs. of powder at a 6-inch back-plate at a range of 75 yards.
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Muzzle of the Mackay 12-pounder Windage Gun, which competed at Shoeburyness in June, 1865. This gun fired 1,300 rounds previous to the muzzle being cut off. Weight of projectile, 11 lbs. 10 ozs.; charge, 1¼ and 2 lbs. of powder. The extreme range of the gun before the muzzle was cut off, was at 25° elevation from 6,500 to 6,800 yards, with 2 lbs. of powder and 12-lb. shot.

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Presented.

A Gun dropped overboard during the Siege of Gibraltar and recovered a short time since.

Captain H.R.H. the Duke of Edinburgh, K.G., R.N.

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OF THE

ROYAL UNITED SERVICE INSTITUTION,

CORRECTED TO THE

1ST JANUARY, 1868.

WHITEHALL YARD, LONDON.
[APRIL, 1868.]

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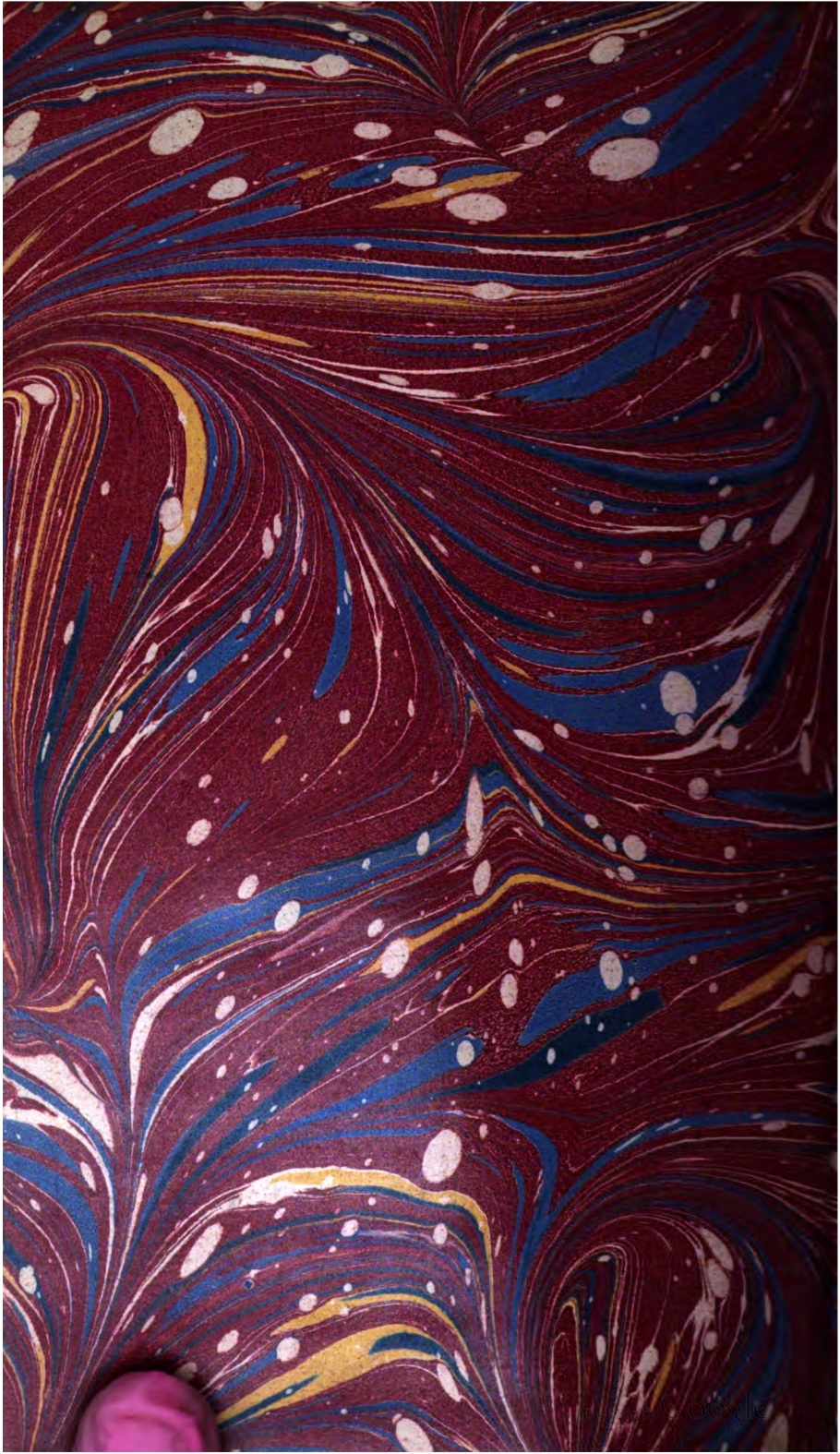
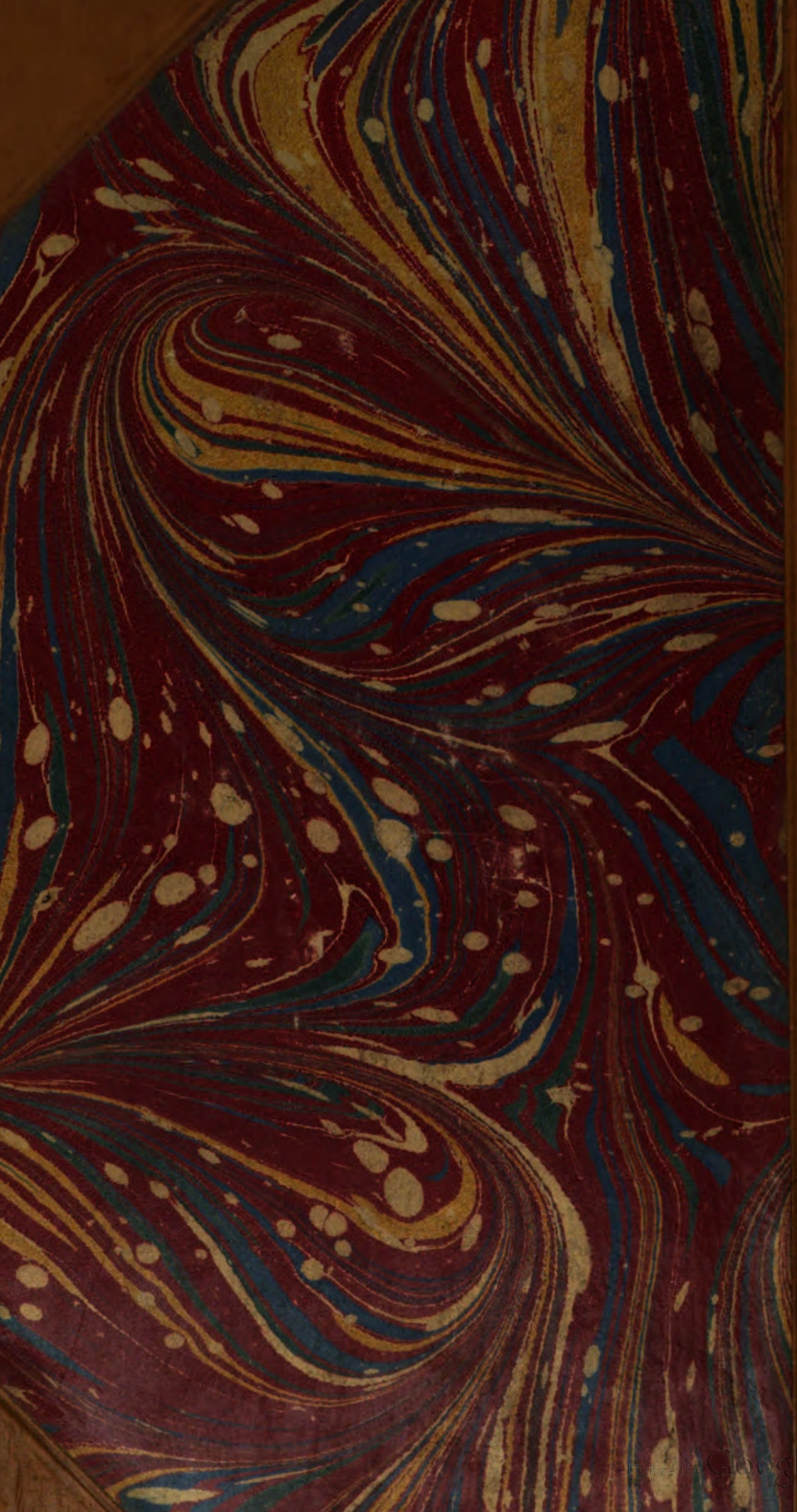
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